



Province of
British Columbia

Ministry of
Environment

EVALUATION OF SOME CONCERNS ABOUT THE USE OF
2,4-D FORMULATED AS AQUA-KLEEN^(R)
FOR EURASIAN WATER MILFOIL CONTROL
IN BRITISH COLUMBIA

Prepared in Consultation with
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PREFACE

This report was assembled by Water Management Branch with information supplied by E.J. Bowmer, M.D. for completion of his contract with the British Columbia Ministry of Environment. Under this contract, Dr. Bowmer conducted a literature survey to assess the health hazard from use of the herbicide 2,4-D and reviewed information on five topics identified by Water Management Branch as major concerns about 2,4-D use for aquatic weed control. The information reviewed on these five topics has been assembled in this report and is discussed in reference to the health hazard from potential exposure of the public to levels of 2,4-D encountered following herbicide applications to control Eurasian water milfoil in British Columbia.

Dr. Bowmer's curriculum vitae is included in Appendix I.

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INTRODUCTION

The term "2,4-D" is the commercially used abbreviation for the phenoxy herbicide 2,4-dichlorophenoxy acetic acid and its 35 derivative salt and ester forms. This herbicide was first described during the 1940s, and has since been extensively used and studied. On susceptible plants, 2,4-D interferes with physiological processes such as respiration, protein synthesis and enzyme activity, although the herbicidal action is not fully understood (Mullison, 1981).

The commercial preparation of 2,4-D used for controlling nuisance aquatic plants in British Columbia is Aqua-Kleen^(R), which contains 20 percent 2,4-D (by weight) in a low-volatile butoxyethanol ester (BEE) form. The active ingredient (2,4-D BEE) is manufactured by Dow Chemical Company of Midland, Michigan and is formulated into the aquatic herbicide, Aqua-Kleen, by Union Carbide Inc. in Ambler, Pennsylvania. This product was distributed in Canada by Amchem Products Inc., Windsor, Ontario.

The active ingredient of Aqua-Kleen is incorporated in heat-treated attaclay granules. This formulation slows the release of 2,4-D into the water column and concentrates release near the lake bottom where the herbicide can be absorbed by plant roots. The registered product label (Registration No. 9907, Pest Control Products Act) describes the proper and safe use of this herbicide (Appendix II).

In British Columbia, Aqua-Kleen is registered for application at 22 to 45 kilograms per hectare to control macrophyte growth in public ponds and lakes. Before the herbicide can be used in any water body (except a man-made, self-contained pond on private land), permits and authorization must be obtained from the Pesticide Control Branch, Ministry of Environment. Permits stipulate that 2,4-D must be applied by applicators licensed by the Ministry of Environment.

Herbicide use is one of ten technologies tested by the British Columbia Water Management Branch to control the nuisance aquatic plant, Eurasian water milfoil. Twenty-seven reports (Appendix III) have been published on the more extensive tests conducted by this agency. Several mechanical technologies including a float-mounted rototiller, diver-operated dredge, shore based cultivator and large harvester have been adapted for specific weed control purposes. However, none of these technologies has a broad application because they are too slow or too expensive to operate, because they are restricted to shallow water or because they provide only short-term relief from nuisance plant growth.

The Water Management Branch evaluated four herbicides including Diquat (Reglone^(R)), Paraquat (Gramoxone^(R)), Dichlobenil (Casoron^(R)) and 2,4-D (Aqua-Kleen^(R)) for aquatic weed control. Only Aqua-Kleen eliminated nuisance growth for more than one year and this herbicide was selected for more extensive testing in Okanagan Valley lakes during 1977-1981.

A total of 33 Aqua-Kleen applications to control Eurasian water milfoil were monitored by Water Management Branch. Treatment areas ranged from a 0.9 m² laboratory test to spot applications up to 0.4 ha (in attempts to kill small clumps of plants) to large treatments up to 12 ha. Observations were made on the drift and persistence of the herbicide and effectiveness of each treatment in removing nuisance growth. Over 5,000 water samples and 2,000 sediment and plant tissue samples were taken to determine concentrations of 2,4-D following treatments. SCUBA divers observed the condition of plants from several months before to several years following treatments. The British Columbia Fish and Wildlife Branch studied the effect of 2,4-D on non-target organisms including fish, waterfowl and invertebrates. Observations on drift, persistence and effectiveness following treatments appeared in a number of technical reports (Adams and Wallis, 1983; Anon., 1979; 1980a, 1980b, 1980c; Goddard, 1980; Lim, 1978; Lim and Lozoway, 1977; Robinson and Morley, 1980; Robinson, 1981; Rudolph and Dyer, 1981; South and Robinson, 1981) which were summarized by Adams (1983).

Aqua-Kleen granules sink to the bottom and release 2,4-D near the plant roots. The herbicide must be released near the roots to ensure that the maximum amount is taken up and distributed throughout the plant to achieve maximum effectiveness. Application seems most effective during the early growing phase when weed growth is sparse to moderate; later, granules suspended in the dense surfacing foliage do not reach the base of the plants. Other factors observed to reduce herbicide effectiveness were groundwater discharge, rocky substrate or small treatment size. In suitable conditions, however, 2,4-D treatments eliminated nuisance growth of Eurasian water milfoil for up to three years.

The herbicide is applied at a rate sufficient to achieve concentrations in the water and sediment necessary to kill the target plant. Concentrations of 2,4-D persisted in treated areas at levels above the Canadian Drinking Water Standard of 0.1 mg/L (Health and Welfare Canada, 1980) for a maximum of six days and drift at or above this concentration was detected at a maximum of 125 m from large treatments (up to 12 ha) in large Okanagan Valley lakes. Low concentrations of herbicide (just above 0.001 mg/L) were observed to drift up to 2 km and typically persisted for less than 40 days in treatment areas.

Herbicide concentrations in the water column decrease rapidly at first due to dilution and dispersion. Over longer periods, 2,4-D undergoes degradation as a result of bacterial decomposition, plant metabolism and photo degradation (Aly and Faust, 1964; Loos, 1971). If ingested by animals, 2,4-D is rapidly eliminated, chiefly in urine but also in feces. Long term accumulation of 2,4-D residues in living organisms or magnification through food chains is not reported to occur.

During trial applications of 2,4-D in the Okanagan Valley lakes by Water Management Branch, herbicide use permits specified that herbicide concentrations were to remain below detectable levels in the vicinity of active domestic water supply intakes. The lowest level detected by the

Ministry of Environment laboratory was 0.001 mg/L 2,4-D; therefore, levels in domestic water supplies were to remain below 0.001 mg/L. The maximum acceptable concentration of 2,4-D in drinking water established in the Guidelines for Canadian Drinking Water Quality (Health and Welfare Canada, 1980) is 0.1 mg/L which is 100 times greater than the non-detectable level.

Moreover, consumption by an adult (weighing 70 kg) of two litres per day of water with the maximum acceptable 0.1 mg/L 2,4-D would result in ingestion of less than one percent¹ of the maximum acceptable daily intake of 2,4-D recognized by the World Health Organization (1975).

Despite the large safety margins in herbicide treatment permits and in the Drinking Water Standards, concerns were raised about the potential health hazard of 2,4-D applications in the Okanagan Valley lakes used as a source of drinking water. There were different opinions about the acceptability of applying herbicide to water bodies used for domestic supply and what maximum acceptable levels of herbicide should be permitted for short periods of time following 2,4-D applications for aquatic weed control. These concerns prompted a review of selected information on the potential health hazard in applying 2,4-D for control of Eurasian water milfoil.

This document was prepared from research conducted by Dr. E.J. Bowmer on the safety of 2,4-D use for Eurasian water milfoil control, in fulfillment of a contract with the Water Management Branch, British Columbia Ministry of Environment. Information was compiled and reviewed on five topics reported under the following Section headings:

¹ World Health Organization maximum acceptable level of 2,4-D intake is 0.3 mg per kilogram body weight per day. If a person weighs 70 kg then WHO acceptable daily intake would be $0.3 \times 70 = 21$ mg 2,4-D. Assuming a person drinks 2 litres of water with 0.1 mg/L 2,4-D, this would be 0.2 mg 2,4-D intake per day which is $0.2/21 \times 100 = 0.95\%$ of WHO maximum acceptable level of intake.

- Potential Dioxin Contamination of 2,4-D.
- Position of Health Authorities on Use of 2,4-D for Aquatic Weed Control.
- Position of United States Environmental Protection Agency (EPA) on 2,4-D.
- Review of Human Health Hazards of 2,4-D Use Reported by the Department of Health Services, State of California, 1980.
- Review of Public Health Effects of Aquatic Use of 2,4-D Reported by Ruth W. Shearer, Ph.D., for Metro Seattle, 1980.

An extensive literature search was conducted during this project and various articles relevant to 2,4-D safety are listed in either the list of literature cited or literature consulted.

2. TOPICS REVIEWED

2.1 Potential Dioxin Contamination of 2,4-D

Public concern about the potential adverse health effects of 2,4-D intensified after the emergency suspension of 2,4,5-T (2,4,5-trichlorophenoxy-acetic acid) use by the United States Environmental Protection Agency in March, 1979. This concern was raised because of the possible contamination of 2,4,5-T with dioxins, especially 2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD). It was suggested that 2,4-D might also contain toxic dioxins since it is chemically related to 2,4,5-T.

A further cause of public concern arose due to media coverage of the claimed health effects of the controversial Herbicide (or Agent) Orange, used widely in Viet Nam as a defoliant, which consisted of equal parts of 2,4-D and 2,4,5-T with other constituents.

The generic term "dioxin" is the name for a family of compounds which are structurally similar but vastly different in toxicity. The term "dioxin" has often been used incorrectly to designate a single member of the family. This family of compounds contains 75 possible polychlorinated dibenzo-para-dioxins (PCDDs) with a million-fold spread in the dosage level required to kill laboratory animals. The most toxic compounds are those with chlorine atoms located in lateral positions (2,3,7,8); toxicity decreases progressively by moving one or more chlorines to para positions or by having fewer or more positions substituted, or both (Leng, 1979). Those PCDDs with a chlorine atom located at all four lateral positions (2,3,7,8) are extremely toxic. An example is 2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD), possibly the most toxic simple molecule known to man, which is some ten times more toxic than aflatoxin B1 (Harris, 1978). TCDD may occur as a contaminant in the manufacture of some phenoxy herbicides. While not produced during the manufacture of 2,4-D, small quantities of TCDD may be a by-product in the manufacture of 2,4,5-T.

Despite the possible dioxin contamination of 2,4,5-T, the British Advisory Committee on Pesticides (1980) concluded that there is no valid medical or scientific evidence that 2,4,5-T herbicides harm humans, animals or the environment if they are used in the recommended way and for the recommended purposes. This committee stressed that human health risks posed by dioxin contamination in 2,4,5-T formulations may hitherto have been overestimated. 2,4,5-T has not been shown to cause cancer in experimental animals; its teratogenic effects in rodents have been demonstrated neither in other larger animals, nor in the course of long-term human studies. In the unlikely event that it was a mutagen it could only be a weak one, so there was a negligible possibility that any user would be affected even if recommended precautions were not observed.

Until recently Dow Canada manufactured 2,4-D by a "dirty" method which resulted in contamination by minute quantities of some dioxins. Using newly developed methods of analysis, Cochrane et al. (1980) identified 2,7-dichlorodibenzo-para-dioxin, 1,3,7-trichlorodibenzo-para-dioxin and 1,3,6,8 tetrachlorodibenzo-para-dioxin in some samples of commercial 2,4-D products in Canada. Di-isomer dioxins are one million-fold less acutely toxic than 2,3,7,8-TCDD; the tri-isomers are 50,000 times less acutely toxic; the tetra-isomers are 15,000 times less acutely toxic. The concentration of these dioxins ranged from 0.008 ppm to 8.0 ppm. Samples tested did not contain 2,3,7,8-tetrachlorodibenzo-para-dioxin (2,3,7,8-TCDD) using an analytical method believed to be sensitive to one part per billion (0.001 parts per million). The "dirty" method of 2,4-D manufacture has now been discontinued in Canada.

Most 2,4-D formulations, including Aqua-Kleen, are prepared using 2,4-D manufactured by the "clean" method in which no dioxins have been detected. To be absolutely certain, Agriculture Canada performed laboratory analyses on additional samples of Aqua-Kleen in 1981 for the British Columbia Ministry of Environment. No dioxins of the mono, di, tri or tetra chlorinated dibenzodioxin types were found. In the opinion of Dr. W.P. Cochrane (Food Production and

Inspection Branch, Agriculture Canada), dioxins would have been demonstrated at 5 ppb or higher had the Aqua-Kleen formulation incorporated 2,4-D prepared by the "dirty" process. Since dioxins were not detected at 5 ppb it would be most unlikely for them to be demonstrated at the 1 ppb level. Subsequently, samples were tested at the 1 ppb level and no dioxins were detected.

Although some previously available formulations of 2,4-D used for agricultural purposes contained dioxin contaminants, such contaminants are absent from the 2,4-D herbicide used in British Columbia for aquatic plant control.

Much of the concern about 2,4-D arose because of alleged after effects of 2,4,5-T use and because both are phenoxy compounds. No documentation has been found which verifies health effects caused by dioxins in 2,4,5,-T, but alarm was raised when dioxins were detected in some formulations of 2,4-D in Canada. Dioxins in 2,4-D result from certain processes of 2,4-D manufacture or by use of contaminated precursors. The dirty process has been banned in Canada and the maximum permissible level of dioxins in 2,4-D set at 10 µg/g. No dioxins have been detected at >1 µg/kg in Aqua-Kleen. Although 2,4-D and 2,4,5,-T are chemically related, they differ in their chemical structure, methods of manufacture and possible dioxin content. It is therefore considered unreasonable to apply any alleged undesirable attributes of 2,4,5,-T to 2,4-D.

2.2 Position of Health Authorities on the Use of 2,4-D for Aquatic Weed Control

2.2.1 Regulation of Herbicide Use

Health agencies are involved in several capacities in the regulation of herbicides in Canada. In general, herbicide use is controlled by the Federal Pest Control Products Act. Under this Act, pesticides used in Canada are evaluated by the Evaluation Unit, Pesticides Section of the Plant Products and Quarantine Division, Production and Development Directorate,

Inspection Branch, Agriculture Canada. The Evaluation Unit establishes the standards and rules for acceptance for registration of any new product or new use which lacks current registration. Data submitted to the Evaluation Unit also are distributed to four federal departments for consultation in Agriculture, Fisheries and Oceans, Environment and Health and Welfare Canada. In Health and Welfare Canada, members of the following are consulted:

1. The Additives and Pesticides Division of the Health Protection Branch, which advise on the acceptability of toxicology and residue data related to proposed pre-harvest intervals (for pesticides used on food crops) and residue tolerance for the purposes of the Food and Drug Act.
2. The Bureau of Chemical Hazards, Environmental Health Directorate, which would assess occupational, environmental and public health aspects, including advice on first aid statements, toxicological information, use of protective equipment, health effects of residues in water for human consumption and advice relating to packaging instructions.

Registered products are subject to evaluation and re-evaluation in light of new information which may become available after use. Once a product has been registered and becomes established in pest control practices in agriculture or elsewhere, the scope of any re-evaluation process is expanded to include provincial agencies.

The label for the Aqua-Kleen formulation of 2,4-D used for aquatic weed control was reviewed and revised in 1978 (Appendix II). The label cautions that herbicide application should not be made within 1/2 mile (806 m) of any active water intake and water should not be used from the treated area for consumption by humans or live-stock for at least 60 days after application

in confined waters, or for at least 21 days after application in open bodies of water, unless analysis indicates that 2,4-D residues do not exceed that listed in the Guidelines for Canadian Drinking Water Quality (Health and Welfare Canada, 1980). These guidelines were prepared by members of the Federal-Provincial Working Group on Drinking Water and list the maximum acceptable concentration¹ of 2,4-D in drinking water as 0.1 mg/L and an objective concentration² of ≤ 0.001 mg/L.

In British Columbia, the use of pesticides is regulated by the Pesticide Control Act which requires that no one apply a pesticide to public land or to a body of water (other than a man-made self contained body of water on private land) unless a herbicide use permit is obtained from the administrator. Requests for herbicide use permits are generally reviewed by the Pesticide Control Committee with representatives from Environment Canada and from provincial Ministries of Agriculture and Food, Forests, Environment, and Health. The member from the Ministry of Health is at present the Director of the Division of Occupational Health.

¹ Drinking water that contains substances in concentrations greater than these limits is either capable of producing deleterious health effect or is aesthetically objectionable as defined by Health and Welfare Canada (1980).

² This level is interpreted as the ultimate quality goal for both health and aesthetic purposes as defined by Health and Welfare Canada (1980).

2.2.2 Use of 2,4-D for Aquatic Weed Control in British Columbia

The herbicide 2,4-D was selected for testing by Ministry of Environment to control Eurasian water milfoil in 1976, after mechanical methods and other herbicides were found to have limited effectiveness during extensive trials performed from 1972 to 1976. Proposals for the testing and use of 2,4-D were generated by the Ministry of Environment and were reviewed by two independent committees with members representing public health interests. In 1973 the B.C. Aquatic Weed Advisory Committee was formed to "assemble relevant information bearing on the subject (aquatic weed control), to investigate jointly the merits of various control methods, and to advise various levels of government and the public on appropriate control measures in various circumstances. The inter-agency co-operation would assist in assuring that all interests were given due consideration..." The various agencies represented on this committee are Environment Canada, Agriculture Canada and B.C. Ministries of Environment, Agriculture and Food, Lands, Parks and Housing, and Health. Herbicide use permit requirements were reviewed with the Committee before submission to the Pesticide Control Branch and safety of 2,4-D use was reviewed considering the potential concentrations of herbicide in lake water and drift and persistence of the herbicide following applications. In the fall of 1977, the B.C. Minister of Health and the Minister of National Health and Welfare were asked to review the permissible limit for 2,4-D in drinking water. Neither Minister requested a change in the recommendations of the Canadian Drinking Water Standards and Objectives. The Federal Minister indicated that ingestion of water containing up to 0.100 mg/L of these herbicides is not considered to present an undue risk to human health, although drinking water supplies should not contain this maximum permissible level on a continuous basis.

In October, 1976, an independent "Advisory Committee on the Control of Eurasian Water Milfoil in the Okanagan Lake System" was appointed by the British Columbia Minister of Environment. The three members of this Committee had recently conducted the Royal Commission of Inquiry into the

use of Pesticides and Herbicides (Mackenzie, Oldham and Powrie, 1975). The Advisory Committee made recommendations on the testing of 2,4-D for weed control and annually reviewed progress of the Ministry of Environment Aquatic Plant Management Program. Recommendations included the size of buffer zones between herbicide treatments and active water intakes and the duration that intakes should be closed to use in treatment areas. While the Ministry of Environment was testing the use of 2,4-D BEE for weed control during 1976-1980, the Advisory Committee recommended (Mackenzie et al., 1978) a conservative approach with procedures to ensure no detectable concentrations of 2,4-D in the vicinity of active water intakes (i.e., less than 0.001 mg/L 2,4-D). This level incorporated a 100 fold safety margin over the acceptable level listed in the Guidelines for Canadian Drinking Water Quality.

2.2.3 Views Expressed by Various Medical Groups on the Proposed Use of 2,4-D for Eurasian Water Milfoil Control, 1977-1979.

(i) BRITISH COLUMBIA MEDICAL ASSOCIATION (BCMA)

In 1977, BCMA passed a resolution which stated its opposition to the massive use of 2,4-D in the Okanagan Lake system and the Chairman of the Environmental Health Committee of the Health Planning Council of the BCMA (Dr. R.F. Woollard) elaborated on these concerns in written statements dated May 4, and July 12, 1978. In these documents the Environmental Health Committee of the BCMA consented that the proper use of 2,4-D followed by adequate monitoring was unlikely to contribute to a significant health hazard, but that they were opposed to the use of massive doses of this herbicide in the Okanagan Lake system. Members of the Environmental Health Committee believed:

- "data exists indicating teratogenic, mutagenic and carcinogenic effects of 2,4-D in animals"

- "the importance of public reassurance in the area of environmental contaminants cannot be overemphasized"
- "use (of 2,4-D) in Okanagan Lake would be considered a calculated risk which would have to be balanced against its potential benefit"

In addition, they felt that 2,4-D would not be appropriate to control Eurasian water milfoil because the weed problem had reached the stage where eradication with a herbicide was not possible and other control methods were more effective; therefore, it would be unreasonable to provide funds in support of herbicide use. As the Environmental Health Committee felt many questions remained unanswered, they suggested that the risks of 2,4-D use may outweigh the benefits in the long term.

The Committee wished to establish the principle of making the applicator responsible to prove the safety of a method rather than expect the public to have to prove any dangerous aspects of a method. Because the Committee felt that there was a presumption of hazard with 2,4-D use in an aquatic system, they believed the proponent (Ministry of Environment) must "be prepared to support detailed, multidisciplinary independent public health and genetic monitoring, so that...any adverse effects may be detected early and corrective action taken" (Woolard, 1978)

The Environmental Health Committee believed that one of their roles was to provide accurate information to stimulate public involvement which would allow society to make the best decisions on environmental health and survival.

(11) CANADIAN PUBLIC HEALTH ASSOCIATION (CPHA)

Concerns about the use of 2,4-D in the Okanagan Valley lakes were expressed by the CPHA in three documents: a resolution passed at the business meeting of the B.C. Branch of the CPHA in May, 1979; a press

release with attached document titled Recommendations for Water Quality in B.C. (dated October 22, 1980), and a resolution passed at the Annual General Meeting of the CPHA in April, 1981.

In general, the CPHA opposed the introduction of 2,4-D into any water body used as a source for domestic water supply. A large number of users obtain their drinking water from the Okanagan lakes, which also are heavily used for recreation and as a source for irrigation water.

In addition, from 1979 to 1981 CPHA were opposed to Ministry of Environment use of 2,4-D to treat nuisance aquatic plants because they believed:

- much of the available information on 2,4-D was controversial and conflicting, with some information originating from agencies of questionable repute,
- there was information to suggest that 2,4-D was carcinogenic, mutagenic and teratogenic,
- it would take many years to prove or disprove the long term effects of 2,4-D on human health,
- the Ministry had not taken sufficient precautions to prevent 2,4-D from entering domestic water supplies in the event of a storm or high winds,
- that 2,4-D was not as effective as mechanical methods to control aquatic plants,
- that the funds used on herbicide treatments should have been channeled into less expensive and more productive control methods,
- that 2,4-D was potentially harmful to fish and waterfowl,
- that 2,4-D use may result in oxygen depletion and the proliferation of toxic blue-green algae.

In 1980, the United States Environmental Protection Agency ordered a review of the effects of 2,4-D. CPHA has taken the position that until the results of this review are known, 2,4-D should not be used for aquatic weed control.

(iii) HEALTH OFFICER'S COUNCIL OF B.C.

In contrast to the B.C. Medical Association and Canadian Public Health Association, the Health Officer's Council of B.C. passed a resolution in May, 1978 which supported the use of 2,4-D for aquatic weed control as proposed by the Advisory Committee on the Control of Eurasian Water Milfoil in the Okanagan Lake system. This agency, chaired by Dr. M.R. Smart, Public Health Officer for the North Okanagan Health Unit, noted that there was no scientific evidence to support the claim that 2,4-D in concentrations of 0.001 ppm or less causes teratogenic effects or is carcinogenic in human beings. Furthermore, after 20 years of use of 2,4-D and 2,4,5-T and their analogues in the Okanagan Valley, the incidence of cancer and specific birth abnormalities were no greater in the Okanagan than in other parts of the province.

(iv) SOUTH OKANAGAN UNION BOARD OF HEALTH

Dr. David A. Clarke, Public Health Officer for South Okanagan, represented the South Okanagan-Similkameen Union Board of Health during Pesticide Control Board appeal hearings for permit applications in lakes under their jurisdiction. Dr. Clarke's philosophy was that nothing should be added to water used as a source for drinking water. He noted that there were between 500 and 600 water intakes in the Okanagan lakes chain. He was concerned also about 2,4-D entering irrigation water used on grapes which he believed to be very sensitive to this pesticide.

The South Okanagan-Similkameen Union Board of Health appealed against issuance of permits for Aqua-Kleen use in Kalamalka and Wood Lakes in 1981 as they believed:

- 2,4-D had been ineffective over the previous five years for control of Eurasian water milfoil,
- there was a danger to human health in using 2,4-D in beach areas and near intakes for drinking and irrigation water,
- Agriculture Canada tests had found that ester formulations of 2,4-D were contaminated with dioxins,
- the National Health Protection Branch had advised Agriculture Canada that the potential health hazards posed by dioxins in 2,4-D could not be refuted, and
- the Canadian and American governments had announced that they were undertaking a complete review of 2,4-D due to major information gaps in its safety.

The Board felt that until the results of current national and international 2,4-D studies were completed, Aqua-Kleen use for Eurasian water milfoil control in Okanagan lakes should be discontinued.

The Ministry of Environment withdrew permit requests for Kalamalka and Wood Lakes in 1981 because of lack of unanimous local support for the proposed treatments (opposed by the Regional District of Central Okanagan).

(v) REGISTERED NURSES ASSOCIATIONS OF B.C. (RNABC)

A brief submitted by the South Okanagan Environmental Coalition appealing a pesticide use permit in 1978 indicated that various chapters of the Registered Nurses Association were opposed to the use of 2,4-D for Eurasian water milfoil control. Inquiries were made by Dr. E.J. Bowmer in

1981 to determine why this view had been taken by the Nurses Associations and informal comments were obtained from former executives or members as follows:

- The Registered Nurses Association of British Columbia office in Vancouver was not aware of any RNABC policy statement regarding the use of 2,4-D for control of Eurasian water milfoil,
- The Kelowna Chapter, RNABC, had discussed 2,4-D use to control Eurasian water milfoil, but opinion proved so widely divided that no consensus was possible. They felt that aquatic plant control might be achieved by a combination of all available measures (mechanical and chemical) before the problem became worse,
- The Penticton Chapter, RNABC, had not issued an official statement on herbicide use in the Okanagan lakes, but they believed that 2,4-D was probably not the answer to milfoil control. If 2,4-D was used, the Penticton Chapter thought that close monitoring was vital. Before this issue could be discussed by the chapter, they would require relevant literature.
- The Summerland Chapter, RNABC, had not discussed the use of 2,4-D in the Okanagan lakes for Eurasian water milfoil control. A representative of this chapter indicated she disagreed with the use of sprays and chemicals as they interfere with nature. She felt that 2,4-D treatments in Okanagan lakes were poorly timed as they interfered with heavy recreational use.

2.2.4 The Concern of Medical Groups as it Relates to Proposed Future Use of 2,4-D for Eurasian Water Milfoil Control

Proposals for widespread use of 2,4-D by the Ministry of Environment as part of an integrated Eurasian water milfoil control program in the

Okanagan Valley were curtailed in 1979. Rapid expansion of Eurasian water milfoil had occurred by 1979 and the Ministry of Environment was unable to implement a program sufficiently quickly to bring this plant under control. Routine treatments of nuisance populations of Eurasian water milfoil in high use areas are now required and have become a local responsibility, including choice of control method and program implementation. Mechanical methods including harvesters, dredges and various tillage systems have been employed, as have 2,4-D applications. Considerable data have been generated from Ministry of Environment tests on the effectiveness and drift and persistence of 2,4-D following applications. Experience has shown that in some high-use lake shore areas, 2,4-D is the most cost-effective method for treating nuisance weed populations. Therefore, local agencies have applied and will probably continue to request permits to use 2,4-D in some sites.

The main concerns about 2,4-D treatments expressed by medical authorities appear to relate primarily to large scale use of the herbicide in water used for drinking and irrigation. As future use of the herbicide is now likely to be localized, several concerns may be discounted:

- there should be less concern about the possible drift of 2,4-D in the vicinity of domestic water intakes as the drift and persistence of the herbicide will be minimal from small applications,
- Ministry of Environment analyses of over 2,000 water samples have shown that drift from small and medium-size (up to 12 ha) herbicide applications is small at concentrations greater than 0.1 mg/L. Concentrations in excess of this maximum acceptable level in Guidelines for Drinking Water Quality, 1978, were never observed at distances greater than 150 m from open lake application sites.
- the Advisory Committee on the Control of Eurasian water milfoil in the Okanagan Lake System of British Columbia has reconfirmed (January, 1983) their position that they "see no reason why 2,4-D should not be considered by the Director of Pesticide Control Branch

as appropriate for use anywhere in the province for control of aquatic weeds in confined bodies of water or to control small, localized weed populations in larger water bodies". They indicated their previous water quality objective of 0.001 mg/L 2,4-D was imposed for test applications; this objective had been recommended when it was anticipated that large continuous areas of weeds might be treated. They indicated that now "the Director of Pesticide Control Branch should be guided by the most up-to-date information available", which includes the Guidelines for Canadian Drinking Water Quality 1978 (Health and Welfare Canada, 1980).

- concerns about fish kills and algal blooms are not now so relevant in view of the probable localized nature of future herbicide applications. No noxious algal blooms or fish kills have been observed following the 33 experimental applications in 1976-1980. Monitoring of 2,4-D trials by Fish and Wildlife Branch in 1977-1978 failed to document fish kills or significant adverse impacts on waterfowl or invertebrates (Robinson and Morley, 1980; South and Robinson, 1982).
- effects of 2,4-D on grapes were not really a medical concern but current studies in the State of Washington, U.S.A. indicate that grapes would not be susceptible to concentrations of 2,4-D which would drift outside small to medium-size (<12 ha) application sites¹.

Concerns about dioxin contamination of 2,4-D used for aquatic weed control are not supported by recent research by Agriculture Canada. Theoretically dioxins are produced during some "dirty" manufacturing processes and analyses have shown that 2,4-D used in Aqua-Kleen is manufactured by a "clean" process.

¹ No effects on grapes were observed with one year treatment using 2,4-D conc. of 0.1 mg/L or less in irrigation water (R.D. Comes, 1982).

The views of various medical groups were inconsistent and a number appeared to lack specific knowledge about 2,4-D, how it is used for aquatic weed control, past experiences with 2,4-D use and objectives of proposed applications in the Okanagan Valley. Some of the expressed concerns were not in the field of human health (e.g., the effectiveness of 2,4-D for Eurasian water milfoil control; potential effects of 2,4-D on water quality) and challenged the opinions and data of specialists in other fields. Those agencies, without specific knowledge of research on the human safety of 2,4-D, tended to take a cautious approach and suggested that 2,4-D use be abandoned until further information was available. They typically generalized about the potential health hazard and did not relate the degree of hazard to concentrations of 2,4-D which might be contacted (objective concentrations during tests by the Ministry of Environment were non-detectable, which was 100 times less than acceptable levels in the Guidelines for Canadian Drinking Water Quality). Those health agencies responsible for review of pesticide safety have continued to accept use of 2,4-D for aquatic weed control. The lack of any significant evidence of a health hazard from 2,4-D use as an aquatic herbicide and the long history of use of this chemical support its continued use.

2.3 Position of the United States Environmental Protection Agency (EPA) on 2,4-D

To ensure safe use of 2,4-D in control of nuisance aquatic plants, the Ministry of Environment conducted literature searches during the mid-1970s and contacted various medical authorities and toxicology research groups. Following these efforts, the Ministry concluded that 2,4-D use posed no threat to people or the environment. However, by 1977, media coverage of herbicide applications questioned the safety of this herbicide, and consequently the general public became concerned.

Unfortunately, some of the media reporting was incorrect and as this became recycled throughout the various news services it only served to alarm the public. The Ministry conducted further inquiries in 1978 and in that year contacted the EPA regarding their current opinion on the use of this herbicide.

In a telex message received by the B.C. Minister of Environment on May 1, 1978, EPA outlined a brief history of events leading up to their most recent decision regarding 2,4-D safety. Earlier EPA policy was based on various studies including that of Hansen et al. (1971). Hansen et al. studied the chronic toxicity of 2,4-D in rats and dogs, and concluded that this pesticide was not carcinogenic in either animal group. Later, a consultant for the EPA Cancer Assessment Group reviewed the Hansen study and informally reported that the data indicated positive evidence for the carcinogenicity of 2,4-D.

Although the Cancer Assessment Group had not itself reviewed the Hansen study, EPA felt that the contradictory finding called for additional reviews by their own staff and independent agencies. The National Cancer Institute (NCI) and the National Centre for Toxicological Research (NCTR) were both requested to provide position statements on the study. NCI determined that the Hansen data "presented no convincing evidence of carcinogenicity". However, NCTR "found the Hansen data suggestive of positive evidence of carcinogenicity". NCTR also reported that they felt the data demonstrated the potential for other chronic health effects which were not evaluated by the researchers (Johnson, 1978).

As NCI and NCTR reviews conflicted with each other, EPA was not able to provide the B.C. Ministry of Environment with a position statement regarding the potential health effects of this herbicide. As it did not appear that continued use of 2,4-D was imminently hazardous EPA determined that it was not necessary to ban further use. EPA indicated that they were continuing their review and evaluation of the pesticide.

Following a period of review, EPA announced, in April 1980, that there were information gaps in the toxicology data base for 2,4-D compounds. By May 1980, a Scientific Advisory Panel for the EPA Federal Insecticide, Fungicide and Rodenticide Act completed a special review of the alleged gaps and determined which tests were required for continued pesticide registration. The panel recommended that studies be carried out on neurotoxicity, reproduction, oncogenicity, animal metabolism, dermal absorption, acute oral toxicity, and the potential effects on fish and wildlife.

In August 1980, EPA issued an order to U.S. 2,4-D registrants requiring them to undertake studies to fill the above gaps in the 2,4-D toxicology data base (Environmental News, 1980). EPA began their own tests on the reproductive effects of 2,4-D derivatives to obtain new information and to provide a basis with which to compare data from industry.

EPA did not feel it was necessary to use their Rebuttable Presumption Against Registration (RPAR) power because available information on potentially harmful human health effects of 2,4-D did not support its removal from the market. Scientific studies indicated that the continued use of 2,4-D would not pose any hazard or adverse effect as long as label directions and precautions were adhered to.

During January 1981, EPA issued a new notice modifying the August, 1980 order. This notice selected certain 2,4-D products which could be tested as representative of groups of products, thereby decreasing the burden of testing all 2,4-D products.

Following the EPA order, seven of the largest manufacturers of 2,4-D organized an Industry Task Force to share the responsibility for research and collection of data on manufacturing-use products. Because manufacturers were complying with EPA requests, 2,4-D remained on the market while testing was taking place. The EPA intended to continue examining data submitted

during toxicity testing, investigating reported incidents involving human exposure, supporting field tests of 2,4-D, and reviewing forest pest control practices. If EPA became aware of potential harmful effects they would take the appropriate regulatory action.

Results from toxicity tests were expected from late 1981 to late 1983; however, EPA granted extensions of deadlines. At this time (fall, 1983) progress reports do not support the deregistration of 2,4-D by EPA.

2.4 Review of Human Health Hazards of 2,4-D Use Reported by the Department of Health Services, State of California, 1980

The Hazard Alert System (HALTS) of the California State Department of Health Services published the report: "2,4-Dichlorophenoxyacetic Acid (2,4-D). Evaluation of the Human Health Hazards" on 16 June 1980. The HALTS group intended this report to provide "complete, up-to-date information on the known and projected human health hazards of 2,4-D". The authors alleged that the report was based on published world literature, case studies, and an investigation into a 2,4-D related neurotoxicity in an exposed worker.

The HALTS report discusses five toxic reactions as they pertain to human health:

Acute toxicity - In man, "2,4-D is of low apparent acute toxicity". "The oral LD₅₀ has been estimated between 80 and 800 mg/kg, most frequently at 400 mg/kg, although this is based on little available data." At the time the report was released, there had been four published cases of acute accidental ingestion of 2,4-D. One swallowed an unknown amount of 2,4-D, and was found dead. Subsequent autopsy revealed tissue concentrations of 80 mg/kg. A second became comatose 20 hours after swallowing an unknown

amount of 2,4-D and died 6 days later. A third victim consumed approximately 110 mg/kg of 2,4-D in association with other compounds (which probably did not contribute to toxicity) and completely recovered after a 48 hour period of acute illness (vomiting, fever, rhabdomyolysis). A fourth victim also recovered although there is no record of his reaction to the herbicide or to the quantity consumed.

Neurotoxicity - "Although 2,4-D has been used extensively with relatively few precautions, skin exposure has been reported in a few individuals to produce a severe peripheral neuropathy". Seven such cases are documented in English language publications. Although neurotoxicity appears uncommon, its actual incidence is unknown, and it may frequently go undiagnosed. In all seven cases the manifestations started within two weeks of exposure to a liquid preparation of 2,4-D on the forearms or legs, with no subsequent attempt to wash it off. Various degrees of motor and sensory impairment developed in the extremities, and in some cases, paralysis. Accompanying symptoms included variable degrees of stiffness, pain and abnormal muscle contractions. Recovery in these cases was generally slow, requiring weeks and sometimes months. Some residual deficits remained in some cases but there were no functional disabilities.

In a few of the above cases the individual was exposed to 2,4-D mixed with other herbicidal compounds, however in most, 2,4-D was the sole herbicide. "None of the other herbicides involved have been otherwise implicated in peripheral neuropathy...Although in most cases the other constituents of the formulation were not reported, ethylene glycol was usually present and is a common solvent for 2,4-D esters...There is a large literature available on ethylene glycol poisoning, which has certain characteristics...but not peripheral neuropathy. A possible role for ethylene glycol in these cases is to increase the percutaneous absorption of 2,4-D."

Carcinogenicity: Data concerning human exposure to 2,4-D is limited. The only published reports which link sarcoma development to herbicide use involve exposure to 2,4-D plus other pesticides - often 2,4,5-T. Therefore, it is not possible to conclude any possible carcinogenic effect for 2,4-D itself in humans. Present information depends heavily on extrapolations from studies using rats, mice and dogs.

Innes et al. (1969) tested the effects of 2,4-D plus its esters on mice and concluded that "2,4-D was not carcinogenic". Reuber (1979) reviewed this study and reported that "the isooctyl ester of 2,4-D was carcinogenic in mice." The HALTS staff reviewed both of these reports and decided that "the data presented are not sufficient to demonstrate carcinogenicity."

Hansen et al. (1971) subjected rats to five levels of 2,4-D and reported that the herbicide "did not produce a significant increase in tumours in any specific tissue", although the incidence of tumours was higher in all dosed groups compared to control groups. It was concluded that "a carcinogenic effect of 2,4-D had not been demonstrated" because the tests "had failed to demonstrate at any single dose level a significant increase of a specific type of tumour in a particular tissue".

In an unpublished re-evaluation of the Hansen et al. study, Reuber (1979) reported "substantially more tumours among the dosed animals than were originally described." Reuber concluded that 2,4-D was "a carcinogen in rats." The HALTS staff reviewed Reuber's study and supported the conclusion that there were significantly more lymphosarcomas in female rats.

In another study, Archipov and Kozlova (1974) painted solutions of 2,4-D and methylcholanthrene (separately and together) onto the skin of mice for three weeks. After 20 months, 17.7% of those painted with a combination of the two chemicals developed skin papillomas. Mice painted with either

chemical did not exhibit papilloma growth. The HALTS group recognize that skin painting is not an appropriate standard cancer bioassay. Papillomas can be benign. The results are suggestive of a tumor-producing effect of 2,4-D in combination with another chemical.

Using dogs, Hansen et al. (1971) were not able to find significant neoplasm development following 2,4-D administered in food at 10, 50, 100 and 500 ppm over two years. HALTS dismiss the findings of this study due to inadequate test design.

The HALTS group carefully evaluated all of these studies and concluded that they did not demonstrate conclusively 2,4-D's carcinogenicity, however they felt that data suggest that the tumour incidences may be in response to this chemical.

Teratogenicity: "High doses of 2,4-D administered to pregnant rats, mice and possibly hamsters can produce a consistent pattern of skeletal abnormalities in their offspring." "In general, the minimal doses required to adversely effect cffspring in these species fall between 1/8 and 1/2 of the LD₅₀. In comparison with other phenoxy herbicides (2,4,5-T), 2,4-D appears as a 'weak teratogen' in many rodent species." There was no mention of tests on other groups of organisms.

Mutagenicity: Mutagenicity tests of 2,4-D did not yield a clear result. There is evidence that 2,4-D is capable of producing mutations; the most convincing test that the HALTS staff was aware of was a Drosophila (fruitfly) sex-linked recessive lethal assay. Information on mammalian mutagenicity is inadequate to draw conclusions.

HALTS concluded that:

1. Acute adverse effects of 2,4-D occur only at high doses, therefore 2,4-D is of low acute toxicity.
2. Cutaneous exposure to commercial preparations containing 2,4-D has resulted in severe peripheral neuropathies in a small number of reported cases.
3. In certain test systems (Drosophila) 2,4-D is a demonstrated mutagen.
4. 2,4-D's carcinogenicity in test animals is suggestive, but the nature of the data is such that a final evaluation cannot be made.
5. Tests in rats and mice support the conclusion that 2,4-D adversely affects the developing fetus at high doses.
6. 2,4-D does not bioaccumulate in animals.

In response to the above findings the following should be noted:

1. The oral LD₅₀ for man lies between 80 and 800 mg/kg. As these are high levels, acute adverse effects would only result from intentional consumption or through total disregard for worker protection.
2. There have been four published cases of acute toxicity related to 2,4-D consumption. One of these cases involved the consumption of 2,4-D plus other compounds; two involved the consumption of unknown amounts of 2,4-D. Considering the large number of persons exposed to 2,4-D over the previous 40 years, these four incidents (three of questionable significance) do not suggest a hazard from use of 2,4-D. Seven cases are documented to support the concern for peripheral neuropathy following exposure during application of 2,4-D. Again, this is a small number of incidents when compared to the number of persons exposed; at least 1000 tons of 2,4-D are used annually in California. These seven documented cases may have been individuals who were more sensitive to the herbicide than other people.

4. The two tests which most conclusively supported the hypothesis that 2,4-D was a mutagen involved yeast cells in a low pH medium and fruit flies. Both are suggestive of mutagenicity but neither are conclusive for humans.
5. To determine the effects of 2,4-D on human health more research is required, however, this need was realized before the release of HALTS report and extensive testing has been underway since. The primary proponent of the hypothesis linking 2,4-D and mammalian carcinogenicity is Dr. M.D. Reuber. Dr. Reuber has not personally conducted any studies and his comments are based on his review of the results from two separate studies. The original authors found that 2,4-D did not produce a significant carcinogenic reaction to draw any conclusions, but Reuber reviewed data from these tests and concluded that the herbicide was carcinogenic. Reuber's supervisors have since questioned the validity of his reviews.
6. The amounts of 2,4-D required to affect the developing rodent fetus is high: 1/8 to 1/2 the LD₅₀. No person would come into contact with this level of 2,4-D unless they swallowed a concentrated herbicide product.
7. Studies with human volunteers show that, following ingestion, 2,4-D is quickly absorbed into the body through the gastrointestinal tract, is rapidly distributed, and is rapidly eliminated in the urine. It may therefore be assumed that the human body can quickly eliminate quantities of 2,4-D encountered by a person applying herbicide in the field.

To publicize their conclusions and recommendations, HALTS released a news bulletin on June 24, 1980. Possibly, to be more persuasive in cautioning people to use care in the widespread use of 2,4-D, the author of the news release included reference to the Agent Orange issue even though Agent Orange was not mentioned in the HALTS report. The author noted: that

"2,4-D was...a major ingredient of Agent Orange", that Agent Orange was "used...to destroy forests in Vietnam", and that "two thousand Vietnam veterans have filed claims...arguing that exposure to Agent Orange left them with a variety of illnesses, reproductive problems and disabilities". There was no mention of the 2,4,5-T constituent, of the possible contamination of 2,4,5-T with TCDD, or that these factors rather than 2,4-D were more likely to have a harmful effect on human health.

The news release suggested that 2,4-D may cause long lasting nerve damage ("some damage has lasted for years and is probably permanent"). Such statements imply there is a good possibility of serious damage; this does not agree with the finding in the HALTS report. Only seven cases exist in the literature linking 2,4-D use to neuropathy. This number is insignificant when related to the thousands of individuals exposed to the herbicide.

On June 24, 1980 the Los Angeles Times printed an article based on the HALTS news release, and suggested that the California Department of Health Services had issued a herbicide alert. The article was sensational in reporting that the state Department of Health had released the first hazard alert of its kind to warn the public that 2,4-D exposure may cause lasting nerve damage, as well as cancer or birth defects. 2,4-D and 2,4,5-T were negatively linked. The newspaper article expanded on the information provided by the news release and HALTS report to include unsubstantiated material (i.e.: "groups of concerned citizens and doctors contend 2,4-D is causing birth defects and miscarriages among women who have been exposed to pesticide sprays"). The newspaper followed the news release example and included a reference to Agent Orange. Finally, the author of the newspaper article contacted Marc Lappe, Chief of the Health Services Department, to comment on the herbicide. Apparently, Lappe was misquoted in the article; furthermore, the HALTS conclusions regarding teratogenicity and carcinogenicity were not warranted by the observations cited.

Publication of the HALTS report followed by the news release and newspaper article failed to contribute new information about the effects of 2,4-D on human health. HALTS did not intend their report to be interpreted as a Hazard Alert, but to warn persons handling 2,4-D to exercise caution (Lappe, 1980). To support this objective they presented evidence which was suggestive rather than proven (i.e., "Although (neuro) toxicity appears uncommon...it may indeed frequently go undiagnosed") and introduced unvalidated material (i.e., the supposed and unsubstantiated link between herbicide spraying in Oregon forests and incidences of miscarriages). As a result, the general public were alarmed and became further misinformed about 2,4-D use because they would naturally assume that these were new and verified findings.

The HALTS report hoped to indicate the need for more research to determine the health effects associated with 2,4-D use because the only information available was based on the small number of animal studies which suffered from contradictory interpretations. By 1978, the United States EPA had coordinated reviews of the same studies which would later be the basis for the California Department of Health Services HALTS report. The EPA had decided that further research was required, and by the time the HALTS group was releasing their findings on certain toxic reactions the EPA was requesting further studies of the same. Therefore, the necessary research suggested by the HALTS group was already underway as directed by the EPA.

2.5 Review of Human Health Effects of Aquatic use of 2,4-D

Reported by Ruth Shearer, Ph.D., for Metro Seattle, 1980

Eurasian water milfoil and other aquatic weeds became a nuisance in many Seattle, Washington, area lakes during the 1970s. Various methods were employed to control expansion of this nuisance plant. Public concern was

raised because of increasingly widespread use of herbicides and because of lack of reviews of the safety and risks associated with aquatic herbicide use. During the summer of 1978, several Seattle regional agencies organized a study group to review all available aquatic weed control technologies including aquatic herbicides. Ruth Shearer was commissioned to carry out a thorough literature review and to determine the relative merits and disadvantages to the public health of herbicides, including 2,4-D, used for aquatic weed control.

Shearer indicated that 2,4-D has been shown to have a number of acute effects in humans (including headaches, dizziness, impaired senses of taste and smell, nausea, muscular spasms and nerve damage) which could be experienced by people applying the chemical without adequate precautions (Shearer and Halter, 1980). These acute toxic effects were only observed when 2,4-D concentrations were far greater than those found in water following herbicide application to aquatic plants.

Long term effects from low dose exposure to 2,4-D was the major topic of Shearer's report:

"2,4-D was found to be both teratogenic and embryotoxic, with effects noted as low as 0.5 mg/kg/day. This injury was induced at even lower concentrations in the presence of a primary microbial breakdown product of 2,4-D, 2,4-dichlorophenol. 2,4-D was shown to cause point mutations in animal cells, to damage DNA in a manner similar to ionizing radiation, and to stimulate cell division. Testing of 2,4-D for carcinogenicity is inadequate according to present standards, but those inadequate tests demonstrate significant tumor increases, particularly in sarcomas of the lymphoreticular system in both rats and mice. (Note that inadequate studies might invalidate a conclusion of no carcinogenic effect but cannot validate there was a carcinogenic effect).

One study for tumour promoting activity was highly positive, using the mouse skin system. The breakdown product, 2,4-dichlorophenol, is also a good promoter of skin carcinogenesis."

Little reference was made in Shearer's report to effects in man and results of tests in mice, rats and other animals were applied to man exposed to aquatic herbicides in only one example. Shearer cited a study where 0.1 mg/kg body weight/day 2,4-D acid combined with 0.1 mg/kg/day 2,4-dichlorophenol administered to pregnant rats for a 7 day period produced developmental toxicity effects in the fetus. If a 100 fold safety margin is applied to this study then a 50 kg woman would exceed the acceptable tolerance level if she drank more than 40 ml of treated water containing 1.25 mg/L 2,4-D and 1.25 mg/L 2,4-DCP daily during her pregnancy. In this extrapolation, it was assumed that lake water could contain 2.5 mg/L 2,4-D following a herbicide treatment, since this was the concentration which was required (for eight hours) to kill Eurasian water milfoil in lab studies (Elliston and Steward, 1972). Dr. Shearer assumed that after a while 2,4-D will be degraded to 2,4-DCP and these two compounds might be present in roughly equal amounts (1.25 mg/L each) in drinking water.

Shearer's assumptions about herbicide concentrations which could be consumed disregarded past herbicide use permit stipulations in British Columbia that drinking water must not contain concentrations of 2,4-D greater than 0.001 mg/L following aquatic plant treatments. In addition, sampling by the B.C. Ministry of Environment has indicated that 2,4-DCP concentrations were detected (up to 0.01 mg/L) only during the first few hours following herbicide treatments, confirming the instability and rapid breakdown of this compound. No detectable 2,4-DCP (>0.001 mg/L) from aquatic weed applications would be present in drinking water.

Several other specialists have criticized Shearer's review of 2,4-D. Mullison (1981) wrote "This review of the health effects of 2,4-D suffers from a lack of objectivity and/or incomplete reporting since frequently only the adverse aspects of the articles cited are mentioned... This Seattle review cannot be used as an authoritative source of information on 2,4-D."

J. Neisess, Pesticide Specialist, United States Department of Agriculture, Forest Service reviewed Shearer's paper and wrote "Dr. Shearer presents...an overstated use of short-term mutagenic tests for chemical carcinogens...short term tests, by themselves, do not constitute definite evidence that a substance poses a carcinogenic hazard to humans. If 2,4-D is the teratogen or mutagen suggested by Dr. Shearer, we surely would have seen those postulated adverse impacts in the farm or forestry communities who have been using this product extensively for one and one half generations.... An evaluation of human health effects must include an analysis of the evidence of carcinogenicity, teratogenicity, etc., along with an analysis of possible human exposure - in other words, a risk assessment. This report only reviews the toxicological data with no attempt to put dosage levels into a perspective relating to human exposure."

D.P. Morgan, Department of Preventative Medicine and Environmental Health, College of Medicine, University of Iowa reviewed Dr. Shearer's report for the United States Department of Agriculture. His major concern was that Shearer's paper was largely a literative review and there was little assessment of public health effects as promised in the title. "...There is no indication of the frequencies of adverse effects. There isn't even any indication of the frequency of poisonings by these agents... There is no evaluation of the likelihood of human absorption of these chemicals when they are used against water weeds. I find no description whatever of the dosages applied, or the application schedules used in aquatic weed control, no data on binding to vegetation and suspended particles, no infor-

mation on environmental degradation, no consideration of the effectiveness of water purification processes in removing these chemicals, no indication of the human population potentially exposed, or the likely degree of that exposure, from drinking the water or swimming in it."

In general, Shearer's review identified concerns about 2,4-D which include acute toxicity associated with inadequate precautions during application and long term effects which might be caused by exposure to low levels over longer time-periods. It is difficult to draw specific conclusions from her report about the safety of 2,4-D used for aquatic weed control, in consideration of the extremely low concentrations to which the public could be exposed. In addition, the review points out conflicting opinions on the potential carcinogenicity and some genetic effects ascribed to 2,4-D. A major priority for future research is the resolution of these conflicting opinions.

3. SUMMARY AND CONCLUSIONS

- i) Information on the potential dioxin contamination of 2,4-D butoxy-ethanol ester used for aquatic weed control was reviewed. While some 2,4-D formulations could contain certain dioxin compounds, the formulation used in B.C. for aquatic weed control does not. The active ingredient (2,4-D) used in this herbicide is manufactured by a "clean" process, which has never produced the contaminant dioxin TCDD.
- ii) The position taken by various health authorities on the use of 2,4-D for aquatic weed control in British Columbia was reviewed. Medical groups generally took a conservative approach and some agencies stated their opposition to large scale herbicide applications. Some concerns would be eliminated by the rejection of plans for large scale treatments throughout the Okanagan Valley lakes. Small scale treatments would have limited herbicide drift and persistence. Most concerns stated by medical agencies were general in nature. They did not relate any particular health hazard from use of 2,4-D to the very low levels of herbicide that the public could be exposed to following aquatic weed control treatments. Medical authorities responsible for the regulation of pesticides permitted continued use of 2,4-D for aquatic weed control as directed by label and permit directions established by official regulatory agencies.
- iii) The position taken by the United States Environmental Protection Agency on 2,4-D use was reviewed. A scientific advisory panel for EPA completed a special review of gaps in this pesticide's toxicological information in May, 1980. As a result of this review, EPA issued an order which required the commencement of studies on neurotoxicity, reproduction, oncogenicity, animal metabolism, dermal absorption, acute oral toxicity and potential effects on fish and wildlife. EPA did not feel it was necessary to ban the use of 2,4-D as available information on the potential for harmful effects indicated that continued use

would not pose any adverse effect as long as it was used as directed. Completion of the additional studies on 2,4-D is anticipated in 1983 and 1984.

- iv) Contents and publicity surrounding the human health hazards of 2,4-D reported by the Health Services, State of California, were reviewed. This report increased the confusion regarding the safety of 2,4-D by presenting no new data on the effects of 2,4-D on human health, and it introduced unvalidated material that misinformed the public. Newspapers expanded on these unvalidated references to the health hazard of 2,4-D indicating that 2,4-D is causing birth defects and miscarriages and suggested that the Health Services report constituted a Hazard Alert. Subsequently the California Department of Health Services indicated the report was intended only to warn persons handling 2,4-D to exercise caution. They came to the same conclusion as the Environmental Protection Agency that further research on 2,4-D was needed; this is now in progress.
- v) Contents of the Shearer report commissioned by Metro Seattle to evaluate herbicides for aquatic weed control were reviewed. Dr. Shearer reported that the literature indicated potential acute toxic effects from mishandling herbicide during applications and potential long term effects from exposure to low levels including teratogenicity and carcinogenicity. She indicated her concern about the synergistic effects of 2,4-D and its breakdown product 2,4-DCP but at herbicide concentrations much higher than would be encountered following aquatic weed treatments in British Columbia. She indicated there was conflicting opinion about the carcinogenicity of 2,4-D. This report did not relate potential long term effects to the likelihood of human absorption of 2,4-D following aquatic weed control. After reviewing the Shearer report, several independent experts questioned its omissions and its objectivity.

- vi) The safety of 2,4-D has been questioned because of controversies in the interpretation of past toxicological data equating 2,4-D to 2,4,5-T and fear about the potential contamination of 2,4-D with dioxins. Much information on 2,4-D safety is anecdotal and confuses the reader attempting to distinguish verified and unverified conclusions. Even professionals have shown biases in their review of the literature and presentation of data. Unfortunately, little information is directed to specific uses of 2,4-D such as aquatic weed control. However, much concern might be alleviated with the knowledge that human contact of the herbicide from aquatic weed control in British Columbia would be extremely limited. The long history of use and failure to find conclusive evidence of any human health hazard from the enormous amounts of this herbicide used for terrestrial agriculture support its continued use. Additional testing directed by the U.S. Environmental Protection Agency should resolve some of the controversial toxicological information. Their report should be available late in 1984.

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APPENDIX I

Dr. E.J. Bowmer, Curriculum Vitae

CURRICULUM VITAE

Dr. E.J. Bowmer

BIOGRAPHICAL SUMMARY

PERSONAL AND FAMILY

EDUCATION AND QUALIFICATIONS

School

University

Postgraduate

REGISTRATION

PROFESSIONAL EMPLOYMENT

LABORATORY EXPERIENCE INCLUDING RESEARCH

TEACHING

SELECTED PRESENTATIONS AND CONSULTANTSHIPS

PROFESSIONAL SOCIETIES (Past and Present)

COMMITTEES

OTHER INTERESTS

HONOURS, PRIZES, AWARDS

PUBLICATIONS

Publications 1937-40

Publications 1959-80

Abstracts of Papers Presented at Meetings of Laboratory
Section, CPHA

Contributions to Epidemiological Bulletin (1971-75)

Contributions to Canadian Diseases Weekly Report (1975-79)

Communications to International Northwest Conference on
Diseases in Nature Communicable to Man

BIOGRAPHICAL SUMMARY

ERNEST JOHN BOWMER

MC C StJ CD

MB ChB MD (L'pool) MRCS (Eng) LRCP (Lond)

DTM&H FRCPATH FRCP(C)

Educated at Liverpool College and Liverpool Institute, Dr. Bowmer proceeded to the University of Liverpool with a Margaret Bryce Smith scholarship. In 1936-37 he was secretary of the Guild of Undergraduates and in 1937-38 he was founder-editor of the Medical Students' Debating Society's Journal. After qualifying in medicine in 1938, Dr. Bowmer spent two years in general medical practice in Chester and Liverpool, England.

In 1940, Dr. Bowmer joined the Royal Army Medical Corps and served in ranks from Lieutenant to Lieutenant-Colonel in Britain, Middle East Forces, South East Asia Land Forces and Middle East Land Forces during the period 1940 to 1956. Between 1942 and 1944 he served with 91 General Hospital in the Middle East and with 17 Indian Field Ambulance, 4th Indian Division, in Italy and was awarded the Military Cross at Cassino.

After the war, he served as Deputy Assistant Director of Medical Services in South East Asia Land Forces, Singapore; he attended the Army Staff College at Camberley and the Senior Officers' Course and the Specialist Course in Pathology at the Royal Army Medical College in London. As a pathologist he was seconded to the Central Public Health Laboratories in London and to the Microbiological Research Establishment in Porton, England; he also served as pathologist at the Tidworth Military Hospital, at the David Bruce Laboratories and in the War Office Enteric Investigation Team in Egypt. His final task while serving in the British Army as Assistant Director of Pathology and Commanding Officer of the Command Medical Laboratory in Egypt and Cyprus was to move the Command Medical Laboratory from its 20-year site at Fayid in Egypt to Nicosia in Cyprus.

In 1956, on retiring from the British Army, Dr. Bowmer emigrated to Canada; after a few months as physician specialist he was promoted to Director of British Columbia's Public Health Laboratories, responsible for the laboratory diagnosis of communicable diseases throughout the Province. He is on the Honorary Consulting Staff of Vancouver General Hospital, and Clinical Professor Emeritus of Medical Microbiology and Honorary Professor of Food Science at University of British Columbia. He is fellow or member of Canadian, British and American scientific and medical societies and past president of B.C. Association of Laboratory Physicians, International Northwest Conference on Diseases in Nature Communicable to Man, Defence Medical Association of Canada, Tropical Medicine and International Health Division (CPHA), and Canadian Society for Tropical Medicine and International Health.

While investigating incidents of communicable disease (such as typhoid fever, salmonellosis, botulism and tropical, parasitic and viral infections), Dr. Bowmer has published some 50 papers and made many oral presentations to medical, scientific, technological and lay audiences at international, national and local congresses, conferences, seminars and meetings. An abiding interest

in the history of medicine culminated in Dr. Bowmer's appointments as archivist to three national or provincial organizations.

Dr. Bowmer served in the Canadian Militia as Regimental MO to B.C. Regiment (1956-61) and as Commanding Officer of 24 Medical Company (1961-66); he is now Honorary Lieutenant-Colonel, 12 (Vancouver) Medical Company. For his services in St. John Ambulance he was appointed Commander of Most Venerable Order of St. John.

Hobbies: grass hockey, sailing, photography, hiking, writing and talking with people.

CURRICULUM VITAE

NAME: Ernest John Bowmer
MC CSTJ CD
MB ChB MD (L'pool) MRCS (Eng) LRCP (Lond)
DTM&H FRCPath FRCP (C)

DATE OF BIRTH: April 10, 1915

PLACE OF BIRTH: Newcastle-upon-Tyne, England

HOME ADDRESS: 1919 Linden Road,
Vancouver, British Columbia
V6M 1E6 Canada

HOME TELEPHONE: (604) 261-9470

OFFICE ADDRESS: (part-time)
Department of Food Science,
University of British Columbia,
#248 - 2357 Main Mall,
Vancouver, British Columbia
V6T 1W5 Canada

MARRIED TO: Elsie Bowmer née Danson, 1940

CHILDREN: Robert Ian M 1941 Chester, England
Gretta Margaret F 1947 Singapore (deceased)

CITIZENSHIP: British by birth
Certificate of Canadian Citizenship No. 552271, 1967

SOCIAL INSURANCE NUMBER: 703-863-043

FATHER: Matthew Noel Bowmer, 1881-1949, Civil Engineer

MOTHER: Winifred Ethel Bowmer née Lunn, 1885-1933, Teacher

EDUCATION & QUALIFICATIONS:

School:	1923-30	Liverpool College	
	1930-32	Liverpool Institute	
University:	1932	Liverpool - Faculty of Science (Botany, Zoology)	
	1933-38	Liverpool - Faculty of Medicine (MRCS {Eng.}) LMCP {Lond.} MB, ChB)	
Postgraduate:	1948	Camberley - British Army - passed Staff College (p.s.c.)	
	1949	London - Royal Army Medical College. Senior Officers' Course. Leishman Prize (first in order of merit); Parkes Prize (first in Army Health with distinction); Katherine Webb Prize (first in Tropical Medicine and Entomology); Montefiore Prize (first in Military Surgery with distinction) and distinctions in Pathology and Psychiatry	
	1949-50	- Royal Army Medical College - Specialist Pathology Course - passed with distinction	
	1951	- Royal Colleges of Physicians and Surgeons - Diploma in Tropical Medicine and Hygiene (DTM & H)	
	1951	- Royal Army Medical College - Junior Specialist (in Pathology)	
	1954	- Royal Army Medical College - Senior Specialist (in Pathology)	
	1962	Liverpool - MD "Antitoxins of <u>Clostridium botulinum</u> ..."	
	1963	London - College of Pathologists - founder member (MC Path)	
	1968	- Royal College of Pathologists - fellow (FRC Path)	
	1957	Canada - Licentiate Medical College of Canada (by examination) (LMCC)	
	1959	- Royal College of Physicians and Surgeons of Canada Certification in Bacteriology	
	1968	- CRCP (C)	
	1972	- FRCP (C)	
	1963	U.S.A. - American Board of Microbiology Diplomate	

REGISTRATION:

1938	General Medical Council (London Jul)
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- 1976 Overseas List (GMC)
MRCS Eng, LRCP Lond 1938; MB ChB 1938, MD 1962 Lpool;
FRC Path 1968
- 1956 Newfoundland - Medical Board, Medical Register No.1025
- 1957 British Columbia - College of Physicians and Surgeons

PROFESSIONAL EMPLOYMENT:

- Career Summary:
1. 1938-40 General Practice, England
 2. 1940-56 British Army - Royal Army Medical Corps (RANC)
 3. 1956-80 Director, Public Health Laboratories, B.C.
 4. 1980- Author, Consultant, Advisor

1. 1937-38 Liverpool Royal Infirmary - Student Intern
in Orthopaedic Surgery
- 1938 Chester - City Hospital Locum House Physician
- 1938-39 Chester - General Practice Assistant
- 1939-40 Liverpool - General Practice Partner
2. 1940-56 British Army - RANC
Lt. to Lt. Col.

Summary of Service:

*"1792 Ernest John Bowmer. b.10 Apr 1915 at Newcastle-upon-Tyne. MRCS Eng LRCP Lond 1938; MB ChB Liverp 1938; DTN&H 1951. EC/SSC:Lt 3 Jul 40. Capt 3 Jul 41. PRAC:Capt 3 Jul 45 ret sen. A/Maj 8 Oct to 4 Nov 45 and 16 Mar to 17 May 46. T/Maj 18 May 46. Maj 3 Jul 48. T/Lt Col 12 Nov 51 to 28 Jul 54. Retd (Hon Lt Col) 18 Jan 56. Relinquished comm on appt to RCANC 23 Apr 56. MEF (Palestine, Egypt, Lebanon) 1943-43, CNF (Italy) 1943-44 (invalided). SEAC/ALFSEA (Burma, Singapore) 1945-47. Path Spec Nil Hosp Tidworth 1950. Army Vaccine Lab 1950-51. MRD/CDEE Porton 1951-54. MELF 1954-56: BMH Fayid (Senior Bacteriologist, W.O. Enteric Investigation Team) 1954-55, OIC Cent Path Lab Fayid 1955-56, Comd Med Lab Wicosa 1956 (and Assistant Director Pathology, MELF). Junior Specialist in Pathology 1951. Senior Specialist 1954. psc 1949. MC 20 Jul 44. 1939-45 S. Italy S. DN. WN."

* (Commissioned Officers in the Medical Services of the British Army 1660-1960, Vol.II, by Sir Robert Drew. The Wellcome Historical Medical Library, London, 1968, p.318.)

1956 Retired from RANC and emigrated to Canada.

3. 1956-80 Vancouver, B.C.
 - 1956 Physician Specialist - B.C. Ministry of Health, Public Health Laboratories
 - 1956-79 Director, B.C. Public Health Laboratories
 - 1962-80 Honorary Consultant, Vancouver General Hospital
 - 1965-80 University of British Columbia, Faculty of Medicine (part-time) Medical Microbiology
4. 1980 Retirement Projects include consultations, writing and lecturing in food science, medical microbiology, epidemiology of communicable and tropical diseases and history of medicine.

LABORATORY EXPERIENCE INCLUDING RESEARCH:

- 1949-50 London - Royal Army Medical College, Millbank Senior Officers' Course, first in order of merit (distinction in Pathology)
- 1950 London - Specialist in Pathology Course with distinction
 - London - Central Public Health Laboratories, Colindale, London (Lt.Col. H.J. Bensted, Dr. Joan Taylor & Dr. F.O. MacCallum)
- 1950 England - Pathologist Tidworth Military Hospital
- 1950-51 England - David Bruce Laboratories (DBL)
- 1951-54 Porton - Microbiological Research Establishment, Porton, Eng. (MRE)
- 1954-55 Egypt - War Office Enteric Investigation Team
- 1955-56 Egypt & Cyprus - Headquarters Middle East Land Forces - Assistant Director of Pathology and Commanding Officer, Central Medical Laboratory
- 1956 Vancouver-B.C. Provincial Public Health Laboratories B.C.
- 1956-79 Director, Provincial Public Health Laboratories

Highlights of Research: At DBL, research was related to vaccine production, preparation of transfusion fluids and identification of bacterial cultures. At MRE, research included preparation and standardization of antitoxins of Clostridium botulinum Types A, B, C, D and E. In B.C. it was possible to study the epidemiology of botulism and the Laboratories were responsible for the Canadian Botulism Reference Service from 1971-74. Other studies involved: infections with staphylococci, listeriae and anonymous mycobacteria; exotic diseases imported into B.C.; and air pollution.

In Egypt the War Office Enteric Investigation Team studied the high incidence and possible methods of transmission of Salmonella typhi and S. paratyphi among British troops in the Canal Zone of Egypt.

In B.C. an intensive study of the increasing incidence of Salmonella infection was undertaken with a National Health Grant from 1961-66. The study led to the publication of an extensive review "The Challenge of Salmonellosis: Major Public Health Problem" used by the US Center for Disease Control in their seminars on Salmonellosis. The main recommendations were presented as a Brief on Salmonellosis used by the CPHA as the basis for their Policy Statement on Salmonellosis (1965).

Fascinating epidemiological studies arose as a result of a small outbreak of typhoid fever in Burnaby (1959) and of a large outbreak of typhoid on an ocean liner (1970).

The wide range of epidemiological studies undertaken in B.C. in the past quarter of a century is adequately reflected in the attached lists of publications.

TEACHING:

U.B.C.	1964-67	Department of Preventive Medicine - Clinical Instructor
		Department of Microbiology/Medical Microbiology -
	1966	Clinical Assistant Professor
	1969	Clinical Associate Professor
	1971	Clinical Professor
	1980	Clinical Professor Emeritus of Medical Microbiology
	1979	Department of Food Science (Faculty of Agricultural Sciences) - Honorary Professor

Royal College of Physicians and Surgeons of Canada - Examiner in Microbiology for Certification in Pathology

Royal College designated B.C. Public Health Laboratories in 1961 as teaching establishment for residents in Microbiology and Pathology

Courses and lectures in Microbiology for physicians, dentists, nurses, public health inspectors, laboratory technologists and other health scientists.

SELECTED PRESENTATIONS AND CONSULTANTSHIPS:

1962	Honorary Consulting Staff, Vancouver General Hospital
1962	"Epidemiological Role of the Public Health Laboratory." New Clinical Laboratory Tests Course. University of Washington, Seattle.

- 1964 "Role and Functions of the Public Health Laboratory." Annual Meeting, Drug Travellers' Association. Vancouver, B.C.
- 1965 "Methods of Epidemiological Investigation." Seminar on Salmonellosis. 30th Annual Meeting, Washington State Public Health Association Meeting and B.C. Branch CPHA. Harrison Hot Springs, B.C.
- 1965 "Principles of Epidemiology." Three Courses on Salmonellosis. Eugene (1), Lewis, and Clark College, Portland (2), Oregon.
- 1966 "Solid Wastes Disposal." Aerojet - General Corporation, Azusa, California.
- 1966 "Automation in Microbiology and Immunology." 30th Annual Convention, Canadian Society for Laboratory Technologists. Vancouver, B.C.
- 1967 "Some Observations on the Transmission of Salmonellosis." Veterinary Public Health Section, CPHA. Annual Meeting, Ottawa.
- 1968 "Symposium on Tropical Diseases." With Colonel M. Fitch and Dr. D.M. McLean. 59th Annual Meeting CPHA. Vancouver, B.C.
- 1969 "Communication." 35th National Conference, Canadian Institute of Public Health Inspectors. Vancouver, B.C.
- 1970 "Typhoid At Sea: Where There's A Case, There's A Carrier." Vancouver, B.C.
- 1970 "Where are you going?" 2nd All-Canada Meeting on Tropical and Parasitic Diseases and Health. Annual Meeting of Laboratory Section. CPHA, Ottawa.
- 1971 "Rabies in Canada" and "Recent Advances in Rubella." Chairman of two Symposia. 62nd Annual Meeting CPHA. Toronto, Ont.
- 1972 "Implications of the Recent Venezuelan Equine Encephalitis Epidemic in Texas to the Western United States and Canada." Seminar. 39th Annual Meeting Western Branch, American Public Health Association. Portland, Oregon.
- 1975 "Trichinosis in Canada." Joint Meeting Royal Society of Tropical Medicine and Canadian Society for Tropical Medicine and International Health. London.
- 1976 "Bat Rabies" and "International Aspects of Rabies and Control." Pacific Northwest Rabies Symposium. Portland, Oregon.
- 1977 "Microbiological Quality of Drinking Water Study." CPHA, Ottawa.
- 1978 Canada World Youth - Medical Advisor. Vancouver, B.C.
- 1978 "Intestinal Parasites of Man in the Canadian Environment." National Research Council of Canada NRCC No. 18128, 1980 (with Laird, M., Sutton, M.D. et al.) Ottawa.

- 1979 "Primary Health Care Delivery." CPHA Study Tour to the Peoples Republic of China.
- 1980 "Review of 2,4-D as Herbicide for Eurasian Water Milfoil." B.C. Ministry of Environment. Victoria, B.C.
- 1981 "Proficiency Testing Program in Parasitology." (with Dr. J.W. Smith) Ontario Medical Association. Toronto, Ont.

PROFESSIONAL SOCIETIES (Past and Present):

- B.C.
- Vancouver Medical Association
 - B.C. Association of Laboratory Physicians (sec. 1959, v.p. 1960, pres. 1961-63)
 - B.C. Medical Association
 - College of Physicians and Surgeons of B.C.
 - West Coast Medical Historical Society
- Canada
- Canadian Association of Medical Microbiologists (v.p. 1970-72, pres. 1972-74)
 - Canadian Hospital Infection Control Association
 - Canadian Lung Association
 - Canadian Medical Association
 - Canadian Public Health Association
 - Laboratory Division (Council)
 - All-Canada Conference on Tropical and Parasitic Disease and Health (1968)
 - Tropical Medicine and International Health Division (v.p. 1972-73, pres. 1973-74)
 - Canadian Society for Tropical Medicine and International Health (pres. 1978-80)
 - Canadian Society of Microbiologists
- U.S.A.
- American Association for the Advancement of Science
 - American Public Health Association (fellow 1960)
 - Committees on Fellowship and Membership,
 - Evaluation of Performance, Laboratory Section
 - Western Branch (Chairman, Laboratory Section, 1958)
 - American Society for Microbiology
 - Conference of Public Health Laboratory Directors
 - New York Academy of Sciences

North America Conference of State and Provincial Laboratory Directors
(Kimble Methodology Award Nominating Committee)
International Northwest Conference on Diseases in Nature
Communicable to Man (v.p. 1960-61, pres. 1961-62)

Medical Mycological Society of the Americas
Pacific Northwest Society of Pathologists

U.K.

Association of Clinical Pathologists
British Medical Association
International Association of Physicians for the Overseas
Services
Liverpool Medical Institution
Royal Society of Health (Member, MRSB 1959; fellow, FRSH 1965)
Royal Society of Medicine
Society for General Microbiology

COMMITTEES:

6th International Congress for Microbiology, Rome, 1953
Committee on Bacterial Nomenclature
Subcommittee on Clostridium
B.C. Ministry of Health Laboratory Advisory Council (1956-78)
Subcommittees on Equipment and Building and Planning
Dominion Council of Health Technical Advisory Committee on
Public Health Laboratory Services (1956-78)
Health and Welfare Canada, National Health Grants
Subcommittee on Microbiology (1968)
B.C. Institute of Technology
Advisory Committee on Medical Laboratory Technology
(1963, Chairman 1970-80)
Advisory Committee on Financial Awards (1981)
B.C. Ministry of Health Committee on Communicable Diseases
Minister of National Health Advisory Committee on Food
Safety Assessment (1972-75)
Agriculture Canada Expert Committee on Food Safety (1978-81)

OTHER INTERESTS:**Boy Scouts**

- 1923-30 181st Troop Cub to King Scout
- 1932-34 350th Group Rover, Assistant Scout Master
- 1934-36 336th Troop Sea Scout Master

Liverpool College Old Larpoolian Society

Liverpool University (1932-38)

- 1934-38 Medical Students' Debating Society (MSDS) Council
- 1936-37 Guild of Undergraduates Secretary
- 1937-38 Journal of MSDS Founding Editor
- 1936-38 National Union of Students (NUS) of Great Britain
Medical Section Secretary and Convener
- 1932-38 Grass Hockey Club and Sefton Hockey Club
1937 Selected for Lancashire County trial
- 1937-38 Sailing Club Inter-University 6m class regatta
Royal Glasgow Yacht Club

Canadian Militia

- 1956 Commissioned in Canadian Militia as Lt.Col.
- 1956-61 British Columbia Regiment (Duke of Connaught's Own)
Regimental Medical Officer
- 1961-66 24 Medical Company, Vancouver, Commanding Officer
Defence Medical Association (DMA) of Canada
(pres. 1968-69)
- 1964 Canadian Polish Congress, B.C. Branch
For Our Freedom and Yours
- 1968 Conference of Defence Associations (CDA) of Canada
United Services Institute (USI) of Vancouver
(v.p. 1971-72, pres. 1972-74)
- 1973-74 Federation of Military and United Services Institutes
of Canada (FMUSIC), Deputy Organizational Director
- 1956-78 Royal Canadian Military Institute, Toronto

St. John Ambulance

- 1938-56 Lecturer and examiner in first aid
- 1965 Provincial Medical Advisory Committee and B.C. Trauma
Committee

- 1973 Provincial Surgeon, St. John Brigade B.C.
 1976 Provincial Medical Advisory Committee, chairman

Philately British North American Philatelic Society (BNAPS)

Royal Canadian Geographical Society

Photography Horner Physicians' Art Salon and Calendar
 "Chinese Sunset" E.J. Bowmar, M.D. Vancouver, B.C.

Award: Slide Transparencies and
 Award: Debut Slide Transparencies

1980 113th Annual Meeting, Canad. Med. Assoc., Vancouver,
 B.C. Sep.

1982 Horner Physicians' Art Salon Calendar

HONOURS, PRIZES, AWARDS:

- 1924-29 Liverpool College - Six annual prizes for Natural
 History
- 1932 Liverpool Institute - Margaret Bryce Smith Scholarship
 to the University of Liverpool
- 1944 Military Cross (MC) 4th Indian Division
 (17 Indian Field Ambulance) Cassino, Italy
 (London Gazette 20 Jul 44)
- 1939-45 Star, Italy Star, Defence Medal, War Medal
- 1961 Canadian Forces Decoration (CD)
- 1962 Bar to Canadian Forces Decoration
- 1973 R.R. Parker Memorial Lecturer
 28th International Northwest Conference on
 Diseases in Nature Communicable to Man. Ashland,
 Oregon. "Natural History and Communicable
 Diseases: The Host-Parasite Relationship."
- 1973 American Veterinary Epidemiology Society, Honorary
 Diploma
- 1973 International Who's Who in Community Service
 Diploma of Honor for Community Service
- 1976 International Northwest Conference on Diseases in
 Nature Communicable to Man, Honorary Life Member
- 1977 Canadian Silver Jubilee Medal

Most Venerable Order of St. John of Jerusalem

- 1975 Serving Brother (SBStJ)
- 1978 Officer Brother (OStJ)
- 1982 Commander Brother (CStJ)
- 1981 12 (Vancouver) Medical Company
 Honorary Lieutenant-Colonel
- 1983 Vancouver Medical Association
 Osler Lecturer

Biographical Listings (Present and Past)

- Who's Who in British Columbia
- Social Register of Canada
- American Men and Women of Science
- Who's Who in the West
- Personalities of the West and Mid-West
- Community Leaders of America
- International Who's Who in Community Service
- Two Thousand Men of Achievement
- Dictionary of International Biography
- Royal Blue Book
- Commissioned Officers in the Medical Services of
the British Army, 1660-1960

Archivist

- B.C. Association of Laboratory Physicians
- Canadian Society for Tropical Medicine and
International Health
- Canadian Association of Medical Microbiologists

PUBLICATIONS 1937-40

ERNEST J. BOWMER

1937

Questionnaire. Guild of Undergraduates, University of Liverpool, 1937.

Questionnaire Report. Guild of Undergraduates, University of Liverpool, 1937.

Questionnaire Report---More Information from your Answers. University of Liverpool Sphinx, 22, 1937.

Editorial. University of Liverpool Medical Students Debating Society Sphinx, 1, No. 1, 5, 1937. National Union of Students Medical Conference. University of Liverpool M.S.D.S. Sphinx, 1, No. 1, 21, 1937.

1938

Editorial. University of Liverpool M.S.D.S. Sphinx, 1, No. 2, 5, 1938.

Service for Medical Students. University of Liverpool M.S.D.S. Sphinx, 1, No. 2, 14, 1938.

"Digs or ...?" University of Liverpool M.S.D.S. Sphinx, 1, No. 2, 28, 1938.

Editorial. University of Liverpool M.S.D.S. Sphinx, 1, No. 3, 5-7, 1938.

Guild of Undergraduates Lecture System Report. University of Liverpool M.S.D.S. Sphinx, 1, No. 3, 16, 1938.

Beautiful viscera. University of Liverpool M.S.D.S. Sphinx, 1, No. 3, 28, 1938.

Medical Students' Committee. University of Liverpool M.S.D.S. Sphinx, 1, No. 3, 31, 1938.

Another lost Soul. University of Liverpool M.S.D.S. Sphinx, 1, No. 3, 33, 1938.

1940

General Practice and the War by a Very Young Practitioner. University of Liverpool M.S.D.S. Sphinx, 3, No. 2, 32, 1940.

PUBLICATIONS 1959-80

ERNEST J. BOWMER

1959

Bowmer, E.J., Hudson, V.G., Sunderland, W.F.: Typhoid Fever: Where There's a Case, There's a Carrier. *Canad. Med. Assoc. J.* 80: 179-186 (1 Feb) 1959.

Bowmer, E.J.: Recent Experiences with Pathogenic Strains of Escherichia coli causing acute Gastro-enteritis in Infants. *Brit. Columbia Med. J.* 1: 586-589 (Aug) 1959.

1961

Bowmer, E.J.: The Sanitarian's Role in the Investigation of Virus Diseases. *Canad. Sanitarian* 5: No.4, 15, 1961.

Bowmer, E.J.: The Role of Biological Agents in Future War.

(a) Air Force College J., Royal Canad. Air Force, 89, 1961.

(b) Reproduced with permission in *Canad. Sanitarian* 6: No.3, 15, 1962, as Biological Agents in Future War.

(c) Extracted with permission in *Marine Corps Gazette* 49: No. 10, 14, 1962, as Biological Agents in Future War.

1962

Bowmer, E.J.: The Sanitarian's Role in the Investigation of Food Poisoning. I. Types of Bacterial Food Poisoning. *Canad. Sanitarian* 6: No. 1, 4, 1962.

Bowmer, E.J.: The Sanitarian's Role in the Investigation of Food Poisoning. II. Methods of Investigation. III. Methods of Prevention and Control. *Canad. Sanitarian* 6: No. 2, 10, 1962.

Bowmer, E.J.: Antitoxins of Clostridium botulinum Types A, B, C, D and E: Preparation and Assay of Proposed International Standards. Thesis submitted for degree of M.D. University of Liverpool, April 1962.

Bowmer, E.J.: The Salmonella Problem - Search for Reservoirs and Vehicles of Human Infection. *Med.Serv. J. Canada* 18: 573-574, 1962.

1963

Bowmer, E.J.: Preparation and Assay of the International Standards for Clostridium botulinum Types A, B, C, D and E Antitoxins. *Bull. Wld. Hlth. Org.* 29: 701-709, 1963.

PUBLICATIONS 1959-80 contd.

ERNEST J. BOWMER

1963

Bowmer, E.J.: So What's Epidemiology?

(a) Lab. World 14: (Dec) 1963.

(b) Communicable Diseases Scotland Weekly Report 12: No. 34, (26 Aug) 1978.

1964

Bowmer, E.J.: The Challenge of Salmonellosis: Major Public Health Problem. Amer. J. Med. Sci. 247: 467-501, 1964.Bowmer, E.J.: The Status of Salmonellosis. Med. Serv. J., Canada 20: 557-560, 1964.

1965

Bowmer, E.J.: Salmonellae in Food - A Review. J. Milk and Food Technol. 28: 74-86 (Mar) 1965.Bowmer, E.J.: Injuries and Infections Caused by the Bites and Stings of Ticks, Spiders, Insects, Snakes, Fish and Mammals. First Aid Attendant 23: Nos. 5 and 6, 4-10 (May/Jun) 1965.Bowmer, E.J.: A Brief on Salmonellosis submitted to the Canadian Public Health Association. Canad. J. Publ. Hlth. 56: 120-127, 1965.Yurack, J.A., Laidley, R.M., McWhorter, A.C., Bowmer, E.J.: A New Salmonella Serotype: S. nissii. Int. Bull. Bact. Nomen & Taxon 5: 243-245 (Oct) 1965.Bowmer, E.J.: Salmonellosis in North America. Modern Med. Canad. 20: No. 12, 31 (Dec) 1965.

1966

Kettys, G.D., Bowmer, E.J., Verrall, V.M.: Enteroviral Infections in British Columbia: An Eight-year Summary. Brit. Columbia Med. J. 8: 279, 1966.

1967

Lynch, A.J., Bowmer, E.J., Sykanda, A., Smith, J.H., Haslie, J.H.: Comparison of Meteorology and Air Quality between two Communities in British Columbia - A Preliminary Report. Canad. J. Publ. Hlth. 58: 241-248 (June) 1967.

PUBLICATIONS 1959-80 contd.

ERNEST J. BOWMER

1968

Bowmer, E.J.: Editorial Section. *Salmonellae: Ubiquitous Pathogens of Animals and Man*. *Canad. J. Publ. Hlth.* 59: 408-410 (Oct) 1968.

1969

Schmitt, N., Bowmer, E.J., Gregson, J.D.: Tick Paralysis in British Columbia. *Canad. Med. Assoc. J.* 100: 417-421 (Mar) 1969.

Robinson, B.L., Grzybowski, S., Bowmer, E.J., McDiarmid, J., Whittaker, E.I., Tanner, K.: Atypical Mycobacterial Disease in British Columbia, 1960-1967. *Canad. Med. Assoc. J.* 101: 17-24 (Jul) 1969.

Bowmer, E.J.: Letters to The Journal. Daniel Lambert the Great. *J.A.M.A.* 210: 906 (Nov 3) 1969.

1970

Schmitt, N., Catlin, H.B., Bowmer, E.J., Larsen, A.A.: Flash Flood at Trail, British Columbia, 1969. *Canad. J. Publ. Hlth.* 61: 104-111 (Mar/Apr) 1970.

Larsen, A.A., Kornder, L.D., Bowmer, E.J.: Rheumatic Fever Prophylaxis - A Method for Detecting Lapses from Continuous Oral Medication. *Canad. J. Publ. Hlth.* 61: 325-328 (Jul/Aug) 1970.

1971

Bowmer, E.J.: Editorial: The Continuing Challenge of Salmonellosis. *Canad. J. Publ. Hlth.* 62: 473-477 (Nov/Dec) 1971.

1972

Schmitt, N., Catlin, H.B., Saunders, K.W.G., Bowmer, E.J.: British Columbia Flash Floods. *EMO National Digest* 11: 1-3, (Dec 1971-Jan 1972) #6.

Ali-Khan, Z., Bowmer, E.J.: Pentastomiasis in Western Canada: A Case Report. *Amer. J. Trop. Med. Hyg.* 21: 58-61 (Jan) 1972.

Bowmer, E.J.: Review: Rapid Diagnostic Methods in Medical Microbiology. ed. Charles D. Graber. *Canadian Doctor* 38: 118 (Apr) 1972.

PUBLICATIONS 1959-80 contd.

ERNEST J. BOWMER

1972

Davies, J.W., Cox, K.G., Simon, W.R., Bowmer, E.J., Mallory, A.: Typhoid at Sea: Epidemic aboard an Ocean Liner. *Canad. Med. Assoc. J.* 106: 877-883 (22 Apr) 1972.

Bowmer, E.J., Campbell, J.A.K.: Index of Drinking Water Pollution - Total Coliform MPN Tests: Confirmed Test Versus Completed Test. *Canad. J. Publ. Hlth.* 63: 355-358 (Jul/Aug) 1972.

Schmitt, N., Bowmer, E.J., Simon, P.C., Arneil, A.S., Clark, D.A.: Trichinosis from Bear Meat and Adulterated Pork Products: A Major Outbreak in British Columbia, 1971. *Canad. Med. Assoc. J.* 107: 1087-1091 (9 Dec) 1972.

1973

Ali-Khan, Z., Irving, R.T., Wignall, N., Bowmer, E.J.: Imported Sparganosis in Canada. *Canad. Med. Assoc. J.* 108: 590 & 593 (3 Mar) 1973.

Bowmer, E.J.: Chap. 18, Diseases of the Gastrointestinal Tract caused by Metazoan Parasites. *In Gastroenterology*, pp. 984-1028, ed. A. Bogoch. McGraw-Hill, New York, 1973.

Bowmer, E.J.: Chap. 19, Diseases of the Gastrointestinal Tract caused by Protozoan Parasites. *In Gastroenterology*, pp. 1029-1050, ed. A. Bogoch. McGraw-Hill, New York, 1973.

Bowmer, E.J.: Chap. 21, Food Poisoning. *In Gastroenterology*, pp. 1087-1112, ed. A. Bogoch. McGraw-Hill, New York, 1973.

Bowmer, E.J., McKiel, J.A., Cockcroft, W.H., Schmitt, N., Rappay, D.E.: Listeria monocytogenes Infections in Canada. *Canad. Med. Assoc. J.* 109: 125-135 (21 Jul) 1973.

Bowmer, E.J.: Filariasis Imported into British Columbia. *Canad. J. Publ. Hlth.* 64: 57-69 (Oct) 1973.

Bowmer, E.J., Whittaker, E.I.: Parasites Galore: Intestinal Parasites in British Columbia, 1956-1972 (17 years). *Canad. J. Publ. Hlth.* 64: 83-92 (Oct) 1973.

1974

Bowmer, E.J.: Be Aware! Beware of Botulism. *Rx Bulletin, Health Protection Branch, Health and Welfare Canada* 5: 34-35 (Mar/Apr) 1974.

PUBLICATIONS 1959-80 contd.

ERNEST J. BOWMER

1974

Bowmer, E.J.: Botulism in Canada. *Canad. J. Publ. Hlth.* 65: 231 (May/Jun) 1974.

Bowmer, E.J.: Trichinellosis in British Columbia: Eight Incidents traced to Pork and Bear Meat. *In* Trichinellosis (Proceedings of the Third International Conference on Trichinellosis). ed. C.W. Kim. Intext Education Publishers, New York, 1974.

1976

Schmitt, N., Bowmer, E.J., Willoughby, B.A.: Food Poisoning Outbreak attributed to Bacillus cereus. *Canad. J. Publ. Hlth.* 67: 418-422 (Sep/Oct) 1976.

Bowmer, E.J., Wilkinson, D.A.: Botulism in Canada, 1971-74. *Canad. Med. Assoc. J.* 115: 1084-1085 (4 Dec) 1976.

1977

Bowmer, E.J.: Summary and Discussion of Question. p. 24. *In* Heyneman, D., Parasites their World and Ours. Proceedings of the 18th Symposium, Royal Society of Canada, ed. A.N. Fallis. Ottawa, June 1977.

Bowmer, E.J.: Summary and Conclusion. pp. 253-258. *In* Proceedings of the International Symposium on Salmonella and Prospects for Control, ed. D.A. Barnum. University of Guelph, June 8-11, 1977.

1978

Hauschild, A.H.W., Bowmer, E.J., Gauvreau, L.: Infant Botulism. *Canad. Med. Assoc. J.* 118: 484 (4 Mar) 1978.

1979

Bowmer, E.J., Conklin, R.H., Steele, J.H.: Listeriosis. *In* Handbook Series in Zoonoses. ed. J.H. Steele. Section A: Bacterial, Rickettsial, and Mycotic Diseases. CRC Press, Boca Raton, Florida, Volume 1, 1979, pp. 423-445.

PUBLICATIONS 1959-80 contd.

ERNEST J. BOWMER

1979

Scheifele, D., Roy, J., Bowmer, E.: Ampicillin resistant *Haemophilus influenzae* in B.C. B.C. Med. J. 21: 408-409 (Sep) 1979.

Bowmer, E.J., Stuart, P., le Riche, W.H., Evis, F.A.: Tropical Disease Increasing in Canada, Prevention and Diagnosis a Major Challenge. World Press Digest 1: 33-35 (Dec) 1979.

1980

McBride, G.B., Skura, B.J., Yada, R.Y., Bowmer, E.J.: Relationship between Incidence of Salmonella Contamination among Pre-scalded, Eviscerated and Post-chilled Chickens in a Poultry Processing Plant. J. Food Protection 43: 538-542 (Jul) 1980.

Ernie Bowmer's COMMONPLACE BOOK. Published privately in Ottawa, 1980.

ABSTRACTS OF PAPERS PRESENTED AT THE
ANNUAL CHRISTMAS MEETINGS OF THE LABORATORY SECTION,
CANADIAN PUBLIC HEALTH ASSOCIATION

ERNEST J. BOWMER

1958

- Bowmer, E.J.: A Human Outbreak of Psittacosis due to Infected Turkeys in a Poultry-processing Plant. *Canad. J. Publ. Hlth.* 49: 27, 1958.
- Bowmer, E.J.: The Detection of a Typhoid Carrier by the use of Gauze Swabs. *Canad. J. Publ. Hlth.* 49: 30, 1958.

1960

- Bowmer, E.J.: Some Observations on the Toxins and Antitoxins of Clostridium botulinum Types A, B, C, D and E. *Canad. J. Publ. Hlth.* 51: 37, 1960.

1961

- Bowmer, E.J.: The Salmonella Problem. *Canad. J. Publ. Hlth.* 52: 35, 1961.

1962

- Bowmer, E.J.: Viral Infections in British Columbia: An Outbreak due to Coxsackie Group B Type 5. *Canad. J. Publ. Hlth.* 53: 33-34, 1962.
- Bowmer, E.J.: Helminthic Infections in British Columbia with a Report of Three Outbreaks of Trichinosis. *Canad. J. Publ. Hlth.* 53: 38, 1962.

1963

- Bowmer, E.J.: The Salmonella Problem in British Columbia. *Canad. J. Publ. Hlth.* 54: 44, 1963.

1964

- Bowmer, E.J.: Salmonella Reservoirs and Vehicles in British Columbia, 1961-63. *Canad. J. Publ. Hlth.* 55: 36, 1964.

1965

- Bowmer, E.J.: The Epidemiology of Salmonellosis: Recent Findings in British Columbia. *Canad. J. Publ. Hlth.* 56: 28, 1965.

ABSTRACTS OF PAPERS contd.

ERNEST J. BOWMER

1966

Bowmer, E.J.: Dermatomycoses in British Columbia. Canad. J. Publ. Hlth. 57: 32, 1966.

1967

Bowmer, E.J.: Epidemiology of Salmonellosis in British Columbia: A 56-month Summary. Canad. J. Publ. Hlth. 58: 25, 1967.

1972

Bowmer, E.J., Wilkinson, D.A.: Canadian Botulism Reference Service. Canad. J. Publ. Hlth. 63: 76 (Jan/Feb) 1972.

Bowmer, E.J.: Filariasis Imported into British Columbia. Canad. J. Publ. Hlth. 63: 90 (Jan/Feb) 1972.

1973

Bowmer, E.J., McKiel, J.A., Cockcroft, W.H., Schmitt, N., Rappay, D.E.: Listeriosis in Canada 1951-1972. Canad. J. Publ. Hlth. 64: 80 (Jan/Feb) 1973.

Bowmer, E.J.: Ursine Trichinosis in British Columbia, 1971. Canad. J. Publ. Hlth. 64: 84 (Jan/Feb) 1973.

CONTRIBUTIONS TO EPIDEMIOLOGICAL BULLETIN
(1971-75)

ERNEST J. BOWMER

- Bowmer, E.J.: Staphylococcal Food Poisoning - British Columbia. *Epidem. Bull.* 15(9): 75-76 (Sep) 1971.
- Bowmer, E.J., Thores, O.A., MacFayden, D.J.: Probable Botulism - British Columbia. *Epidem. Bull.* 15(11): 95-96 (Nov) 1971.
- Bowmer, E.J., Arneil, A.S.: Staphylococcal Food Poisoning - British Columbia. *Epidem. Bull.* 16(3): 19 (Mar) 1972.
- Bowmer, E.J., Lipson, F.: Botulism - Ontario. *Epidem. Bull.* 17(1): 3 (Jan) 1973.
- Bowmer, E.J.: Food Poisoning - British Columbia. *Epidem. Bull.* 17(1): 10 (Jan) 1973.
- Bowmer, E.J., Briggs, S.B.: Mushroom Poisoning - British Columbia. *Epidem. Bull.* 17(7): 85 (Jul) 1973.
- Bowmer, E.J., Robinson, J.M., Coady, C.J., Jackson, A.W., Park, C.E., Todd, E.C.: Staphylococcal Food Poisoning - British Columbia. *Epidem. Bull.* 18(3): 38-39 (Mar) 1974.
- Bowmer, E.J., Frosh, J., Todd, E.C.: Suspected Botulism Proves to be Staphylococcal Food Poisoning. *Epidem. Bull.* 18(3): 27 (Mar) 1974.
- Bowmer, E.J.: Suspected Botulism - British Columbia. *Epidem. Bull.* 18(3): 37 (Mar) 1974.
- Hauschild, A.H.W., Paddon, W.A., Gray, J., Bowmer, E.J.: Botulism Type E in Labrador. *Epidem. Bull.* 18(9): 118-119 (Sep) 1974.
- Bowmer, E.J., Chritchley, J.: Tick Paralysis Simulates Botulism. *Epidem. Bull.* 18(9): 119-120 (Sep) 1974.
- Bowmer, E.J., Hauschild, A.H.W., Hilsheimer, R., Raz, V., Schinbein, J.E., Dalton, J.B., Hopkins, D., Bolduc, W.L.: Botulism and Home-fermented Salmon Eggs - British Columbia. *Epidem. Bull.* 18(11): 149-150 (Nov) 1974.
- Bowmer, E.J., Farquharson, M., Roy, J.J., Meekison, W.G.: Food Poisoning caused by Vibrio parahaemolyticus - British Columbia. *Epidem. Bull.* 19(4): 60-61 (Apr) 1975.

CONTRIBUTIONS TO CANADIAN DISEASES WEEKLY REPORT (CDWR)
(1975-79)

ERNEST J. BOWMER

- Skidmore, A.G., Cockcroft, W.H., Bowmer, E.J.: Severe Candida Infection: Sequel to Illicit Drug Use - British Columbia. CDWR 1: 13-16 (31 May) 1975.
- Hauschild, A., Bowmer, E.J., Gauvreau, L.: Botulism in Canada - Summary for 1974. CDWR 1: (24 May) 1975.
- Bowmer, E.J., Bolduc, W.L., Manji, A., Park, C., Jackson, A.W.: Staphylococcal Food Poisoning - British Columbia. CDWR 1: 23-24 (14 Jun) 1975.
- Bowmer, E.J., Siemans, G., McInnes, W.O.H., Ellis, A.: Staphylococcal Food Poisoning - New Brunswick. CDWR 1: 93-95 (18 Oct) 1975.
- Bowmer, E.J., Theal, G.I., Gibson, G.A., Bandoni, R.J.: Amanita Mushroom Poisoning - British Columbia. CDWR 1: 95-96 (18 Oct) 1975.
- Bowmer, E.J., Kerridge-Judd, P.: Outbreak of Ringworm in British Columbia. CDWR 2: 27-28 (14 Feb) 1976.
- Bowmer, E.J., Meekison, W.G.: Drug Reaction Complicates Food Poisoning Incident. CDWR 2: 122-123 (31 Jul) 1976.
- Bowmer, E.J., Hutchinson, A.K., Meekison, W.G.: Human Infection due to Salmonella wassenaar. CDWR 2: 139-140 (28 Aug) 1976.
- Reynolds, P.J., Bowmer, E.J., Carr, W.G.L.: A Localized Outbreak of Diphtheria - Vancouver Island. CDWR 2: 141-142 (4 Sep) 1976.
- Bowmer, E.J.: Salmonella mbandaka - First Isolation in Canada. CDWR 2: 157 (2 Oct) 1976.
- Bowmer, E.J., MacBean, W.E., Young, C., McGuire, R.: Outbreak of Salmonellosis - British Columbia. CDWR 3: 73-74 (7 May) 1977.
- Bowmer, E.J., Woollacott, P.J.V., Greenwood, R.C.: Wound Infection due to Vibrio parahaemolyticus in British Columbia Coastal Waters. CDWR 3: 97-98 (18 Jun) 1977.
- Bowmer, E.J., Blatherwick, J., Morris, E.B.: Typhoid Imported from Mexico to British Columbia. CDWR 3: 160 (1 Oct) 1977.
- Todd, E., Szabo, R., Woollacott, P., Bowmer, E.J.: Botulism - British Columbia. CDWR 4: 2 (4 Feb) 1978.
- Larsen, A., Constance, P., Bowmer, E.J., Jones, J.E., Wick, J.: Outbreak of Diphtheria - British Columbia. CDWR 4: 59-60 (15 Apr) 1978.

CONTRIBUTIONS TO CANADIAN DISEASES WEEKLY REPORT contd.

- Hauschild, A., Gauvreau, L., Bowmer, E.J.: Botulism in Canada - Summary for 1977. CDWR 4: 79-80 (20 May) 1978.
- Reynolds, P.J., Abdulla, A.H., Peek, C.G., Bowmer, E.J.: A Penicillin-resistant Strain of Neisseria gonorrhoeae - British Columbia. CDWR 4: 118 (29 Jul) 1978.
- Bonham, G.H., Bowmer, E.J., Szabo, R., Todd, E., Gleeson, T.: Staphylococcal Food Poisoning - British Columbia. CDWR 5: 45-46 (24 Mar) 1979.
- Bowmer, E.J., Fung, C.P.J., Neufeld, W., Drew, R., Appleton, G., Gaunt, B.: Scombroid-like Poisoning from Eating Mahi-Mahi Imported into Canada - British Columbia. CDWR 5: 78 (19 May) 1979.
- Bowmer, E.J.: Laboratory Identification of Intestinal Helminths and Protozoa - Provincial Laboratories, British Columbia 1956-1978 (23 years). CDWR 5: 94-95 (9 Jun) 1979.

COMMUNICATIONS TO ANNUAL MEETINGS OF
THE INTERNATIONAL NORTHWEST CONFERENCE
ON DISEASES IN NATURE COMMUNICABLE TO MAN

(INCINCM)

ERNEST J. BOWMER

"An Outbreak of Psittacosis Among Workers in a Turkey-processing Plant
in British Columbia - Epidemiological and Laboratory Findings II".
1957

"Sarcosporidiosis: A Human Case, with Demonstration". 1957

"The Antitoxins of Clostridium botulinum". 1958

"The Salmonella Problem". 1960

"Plans for Studying Reservoirs and Vehicles of Salmonella Infection in
British Columbia". 1961

"Report on Recent Findings of Human Protozoal and Helminthic Infections
in British Columbia". 1961

"Salmonella in British Columbia". 1963

"Salmonella Investigations in British Columbia". 1964

"Salmonellosis in British Columbia: A Four-year Study". 1966

"Listeriosis in Canada 1951-1968: With Report of Nine Cases in British
Columbia". 1968

"Tick Paralysis in British Columbia". 1969

"Salmonellosis of Man and Animals in British Columbia". 1971

"Trichinosis from Smoked Bear Meat". 1972

"Recent Outbreaks of Botulism in Canada". 1973

R.R. Parker Memorial Address: "Natural History and Communicable Disease:
The Host-parasite Relationship". 1973

"Some Intriguing Food-borne Diseases". 1974

"The Threat of Human Rabies in British Columbia: The Doctor's Dilemma".
1975

"Pasteur: The Chemist who Founded Bacteriology and Revolutionized Human
and Veterinary Medicine". 1976

"Man and His Animals - Their Sharing Ways". 1977

COMMUNICATIONS TO ANNUAL MEETINGS OF
THE INTERNATIONAL NORTHWEST CONFERENCE
ON DISEASES IN NATURE COMMUNICABLE TO MAN contd.

"Group B Streptococcal Disease (One of the Bacterial Diseases of Infants Occurring in the First Thirty Days of Life which may cause Septicemia or Meningitis)". 1978

"Toxocariasis as a Human Health Hazard". 1979

Illustrated Report on Canadian Public Health Association Visit to the People's Republic of China. 1980

"WILLIAM BOYD, C.C., M.D., 1885-1919 -- Professor of Pathology, Universities of Manitoba, Toronto and British Columbia". Poster Exhibit. 1982

APPENDIX II

Registered Product Label for Aqua-Kleen

Net Weight

58 75

22.7 kg

AQUA-KLEEN

GRANULAR

A 2,4-D WEED KILLER

FOR CONTROLLING WATER WEEDS

RESTRICTED

GENERAL INFORMATION

AQUA-KLEEN Granular contains 20% by weight of 2,4-D as the low-volatile butoxy ethyl ester. This has been formulated on special heat treated efficacy granules that resist rapid decomposition in water. AQUA-KLEEN Granular sinks quickly to lake or pond bottoms and releases the weed killing chemical in the critical root zone area.

A water-oxygen ratio must be maintained because decaying weeds can use up oxygen that fish breathe. The most efficient use of AQUA-KLEEN Granular is early in the season when weed growth is sparse. During this period, weed decomposition is slow enough to not disturb the water-oxygen ratio, if the entire water body is treated at one time.

If treatments must be applied later in the season when the weed mass is dense, spread granules in lines, leaving buffer strips which can then be treated when vegetation in treated areas has disintegrated. During the growing season, weeds decompose in a 2 to 3 week period following treatment.

Buffer lines should be 50 to 100 feet wide. Treated lines should be as wide as the strips.

For use in public bodies of water, AQUA-KLEEN should be applied by Federal, Provincial or local agency personnel trained in aquatic weed control or by licensed commercial applicators under contract to the above agencies. Refer to permit sections for additional information about private ponds and lakes.

PERMIT TO USE CHEMICALS IN WATER

Permits are required to control weeds by chemical means in public waters. If your lake or pond is private and completely land-locked and not connected at any time of the year to other bodies of water either by an actively flowing stream or by surface seepage, a permit may not be required. Contact your local Department of Environment, Agriculture and/or Fisheries Resources for a permit.

DIRECTIONS — RESTRICTED USES

Notice to User: This control product is to be used only in accordance with the directions on the label. It is an offence under the Pest Control Products Act to use a control product under unsafe conditions.

Restraint of Restriction: This product may be used only in the manner authorized; contact local authorities regarding appropriate use permits that may be required.

This product is to be used only in the manner outlined; contact local officials for the appropriate use permits which may be required.

When to Apply

For best results, spread AQUA-KLEEN Granular in the spring or early summer, during the time weeds start to grow. If desired, this timing can be checked by sampling the lake bottom in areas heavily infested with weeds the year before.

If treatments are delayed until weeds form a dense mat or reach the surface, the higher rate, 225 kg/ha, or two lower rates, 110 kg/ha treatments should be made. Make the second treatment when heavy regrowth occurs or if weeds move in from untreated areas.

Occasionally, a second application will be necessary if heavy regrowth occurs or weeds move in from untreated areas.

This product is most effective in lakes and ponds with relatively slow rates of water exchange. The product may not be effective if applied in fast moving water such as a river or the mouth of a creek.

How to Apply

For large areas, use a fertilizer spreader or mechanical seeder such as the Gerber or Gandy. Before spreading any chemical, calibrate your equipment and method of application to be sure of spreading the proper amount. When using boats and power equipment, you must maintain the proper combination of (1) boat speed, (2) rate of discharge from the spreader, and (3) width of swath covered by the granules.

SUSCEPTIBLE WEEDS

Water hyacinth (*Myriophyllum* spp.)

Water starwort (*Water hyacinth* dubia)

SLIGHTLY TO MODERATELY RESISTANT WEEDS

Bladderwort (*Utricularia* spp.) White water lily (*Nymphaea* spp.) Yellow water lily or spatterdock* (*Ruphris* spp.) Water shield (*Brasenia* spp.)

*Repeat treatments may be needed

This product is designed to control the weeds listed on the label. Control of other weeds may not be satisfactory. Generally, weeds are difficult to control in lakes where water replacement occurs from bottom springs.

Water pH

Lake water that is extremely acid or alkaline may influence the effectiveness of AQUA-KLEEN Granular. A pH on the acid side (pH 5.0 or below) generally favors the action of the chemical while a pH on the alkaline side (pH 8.0 or above) may reduce the action. If regrowth occurs within a period of 6 to 8 weeks, a second application may be required.

Belgrass Control in Maritime Oyster Farms

AQUA-KLEEN effectively controls Marine eelgrass (*Zostera marina*) in Eastern Canadian Oyster farming areas. Application rates will kill weeds and thereby facilitate oyster harvesting. Make only one application per season.

NOTICE TO BUYER: Seller's guarantee shall be limited to the terms set out on the label and subject thereto, the buyer assumes the risk to persons or property arising from the use or handling of this product and accepts the product on that condition.

PRECAUTION

Avoid contact with skin, eyes or clothing. Do not store near fertilizer, seeds, insecticides or fungicides. Do not use in a greenhouse. Clean spreader equipment thoroughly before using it for any other purpose.

CAUTION

Unless otherwise authorized by the agency issuing the governing use permit, do not boat within 10 kilometers of any active water intake.

POTABLE WATERS

Do not use water from the treated area for consumption by humans or livestock for at least

Use the following formula to calibrate your spreader's delivery in Kilograms of AQUA-KLEEN Granular per minute.

Meters per hour X spreader width (meters)

X kilograms per hectare

= kilograms per minute

930

For small areas—around docks or isolated patches of weeds—use a portable spreader such as the Cyclone seeder. Estimate or measure out the area you want to treat. Weigh out the amount of material needed and spread this uniformly over the area. More uniform coverage is obtained by dividing the required amount in two and covering the area twice, applying the second half at right angles to the first.

How to Apply

Spot treatments can be made for small local infestations or for purposes of retreating areas missed in the first application or preventing the establishment of weed fragments drift in from untreated areas.

When spreading AQUA-KLEEN Granular from a boat, we suggest setting out guide poles at frequent intervals marking out the area. This helps to steer a straight course.

Amounts to Use

Rates of application vary with the resistance of weed species to the chemical, density of weed mass at time of treatment, water depth, and rate of water flow through the treated area. Use the higher rate for dense weeds when water is more than 2.4 meters deep and there is a large volume turnover.

AQUA-KLEEN

Kilograms per Hectare	Kilograms per 100 sq. meters
110-225	1.10-2.25
110	1.10
175-225	1.75-2.25

Apply AQUA-KLEEN during the summer when eelgrass has begun to flower. For maximum weed control treat during warm weather when water exchange is at a minimum.

Treat at low slack tide to reduce dilution by water movement. In very shallow areas treat at high slack water.

Natural water movement will spread AQUA-KLEEN beyond the treated area. An additional perimeter around the actual treated area should be regarded as effective if by AQUA-KLEEN.

Treat at least 60 days before the first oyster harvest. Avoid harvesting other shell fish, such as clams, from the treated area and perimeter during the same 60 day period.

60 days after treatment in confined waters, or for at least 21 days after treatment in open bodies of water, unless analysis indicates that 2,4-D residues do not exceed that listed in the Canadian Drinking Water Standards and Objectives.

IRRIGATION

Do not use water from the treated area for the preparation of agricultural spray mixtures for irrigation of 2,4-D sensitive crops for at least 60 days after treatment in confined waters, or for at least 21 days after treatment in open bodies of water, unless an approved analysis shows that the water is suitable for such purposes. Many crops such as tomatoes, legumes, cucurbits, grapes and cole crops are sensitive to 2,4-D.

Do not use this product for purposes other than those recommended on the label.



AGRICULTURAL PRODUCTS COMPANY, INC.
P.O. Box 1198
Chatham, Ontario N7M 5L8

Registration No. 9807 Pest Control Products Act
READ THE LABEL BEFORE USING

GUARANTEE
2,4-D equivalent

APPENDIX III

**List of Reports on Aquatic Weed Control Technologies
Prepared by Water Management Branch**

1973

- Baillie, B.R., D.L. Bissell and W.M.F. Kirk. 1973. Crayfish as a biological control measure for aquatic macrophytes. Progress Report. Water Investigations Branch Report No. 2049, British Columbia Ministry of Environment. 17 pp.

1974

- Newroth, P.R. 1974. Studies on Aquatic Macrophytes. Part IV. A review of the ecology and control of some aquatic macrophytes. Water Investigations Branch Report No. 2169, British Columbia Ministry of Environment. 64 pp.
- Newroth, P.R. 1974. Studies on Aquatic Macrophytes. Part V. Aspects of aquatic weed control by mechanical harvester. 1972-1973. Water Investigations Branch Report No. 2170, British Columbia Ministry of Environment. 54 pp.

1975

- Bryan, A., K. Marsden and S. Hanna. 1975. A summary of observations on aquatic weed control methods. Water Investigations Branch Report No. 2351, British Columbia Ministry of Environment. 23 pp.
- Newroth, P.R. 1975. Management of nuisance aquatic plants. Water Investigations Branch Report No. 2337, British Columbia Ministry of Environment. 27 pp.

1976

- Buchanan, R.J. 1976. Briefing paper on Eurasian water milfoil (*Myriophyllum spicatum* L.). Water Investigations Branch Report No. 2463, British Columbia Ministry of Environment. 16 pp.
- Newroth, P.R. 1976. An outline of aquatic plant management options considered in British Columbia. Water Investigations Branch Report No. 2462, British Columbia Ministry of Environment. 6 pp.

1977

- Bryan, A. et al. 1977. Studies on Aquatic Macrophytes. Part IX. Experimental herbicide treatment for aquatic weed control, Kelowna Boat Basin, Okanagan Lake, 1975. Water Investigations Branch Report No. 2627, British Columbia Ministry of Environment. 55 pp.
- Lim, P.G. and K.R. Lozoway. 1977. Studies on Aquatic Macrophytes. Part X. A field experiment with granular 2,4-D for control of Eurasian water milfoil, 1976. Water Investigations Branch Report No. 2613, British Columbia Ministry of Environment. 105 pp.

1978

- Bryan, A.D. (ed.). 1978. Studies on Aquatic Macrophytes. Part VIII. Experimental hydraulic dredging for aquatic weed control in Vernon Arm, Okanagan Lake, 1975. Water Investigations Branch Report No. 2727, British Columbia Ministry of Environment. 158 pp.

Lim, P.G. 1978. Studies on Aquatic Macrophytes. Part XVI. A laboratory experiment with granular 2,4-D for control of Eurasian water milfoil, 1976-1977. Water Investigations Branch Report No. 2726. British Columbia Ministry of Environment. 25 pp.

1979

Anon. 1979. Studies on Aquatic Macrophytes. Part XVIII. Data report on Eurasian water milfoil treatments with 2,4-D in the Okanagan Valley, 1977-1978. Water Investigations Branch Report No. 2803, British Columbia Ministry of Environment. 127 pp.

Armour, G., D. Brown, and K. Marsden. 1979. Studies on Aquatic Macrophytes. Part XV. Bottom barriers for aquatic weed control. Water Investigations Branch Report No. 2801, British Columbia Ministry of Environment. 34 pp.

Maxnuk, M. Studies on Aquatic Macrophytes. 1979. Part XXII. Evaluation of rotavating and diver dredging for aquatic weed control in the Okanagan Valley. Water Investigations Branch Report No. 2823, British Columbia Ministry of Environment. 69 pp.

Newroth, P.R. 1979. British Columbia Aquatic Plant Management Program. J. Aquat. Plant Manage. 17:12-19.

1980

Anon. 1980. Studies on Aquatic Macrophytes. Part XIX. Eurasian water milfoil treatments with 2,4-D in the Okanagan Valley, 1977-1978.

Volume 1: Description of study area, treatment methods and herbicide residue persistence in the water column and water quality implications. Inventory and Engineering Branch Report No. 2913, British Columbia Ministry of Environment. 142 pp.

Volume 2: Herbicide residue concentrations and persistence in biological tissues and hydrosols. Inventory and Engineering Branch Report No. 2914, British Columbia Ministry of Environment. 72 pp.

Volume 3: Herbicide application effects and efficacy on target plant species. Inventory and Engineering Branch Report No. 2915, British Columbia Ministry of Environment. 69 pp.

Armour, G.C., R.S. Hanna, I.P. Walters, and M.D. Maxnuk. 1980. Studies on Aquatic Macrophytes. Part XIV. Summary of Mechanical Aquatic Plant Management, Okanagan Valley, 1978. Inventory and Engineering Branch Report No. 2917, British Columbia Ministry of Environment. 86 pp.

Goddard, J.M. 1980. Studies on Aquatic Macrophytes. Part XXX. Control of Myriophyllum spicatum in Kalamalka and Wood Lakes using 2,4-D butoxyethanol ester in 1979. Volume 1: Data Report. Water Investigations Branch Report No. 2824. British Columbia Ministry of Environment. 48 pp.

Newroth, P.R. and P.G. Lim. 1980. Studies on Aquatic Macrophytes. Part VI. Experiments with herbicides for aquatic plant management, Okanagan Lake, 1974. (Summary) Inventory and Engineering Branch Report No. 2924, British Columbia Ministry of Environment. 42 pp.

Robinson, M.C. and R.L. Morley. 1980. Eurasian Water Milfoil Studies. Volume II. A Monitoring study of the effects of 2,4-D on fish and waterfowl as applied in lakes of the Okanagan Valley, 1977. Inventory and Engineering Branch Report No. 2918, British Columbia Ministry of Environment. 35 pp.

Stephenson, W., C.M. Alcock, G.D. Armour, and D.D. Baillie. 1980. Studies on Aquatic Macrophytes. Part XIII. Aquatic plant fragment barriers in the Okanagan Basin, 1976-1979. Inventory and Engineering Branch Report No. 2906, British Columbia Ministry of Environment. 97 pp.

1981

Newroth, P.R. 1981. Case Studies of Aquatic Plant Management for Lake Restoration in British Columbia, Canada. Proc. International Symposium on Inland Waters and Lake Restoration. Sept. 8-12, 1980. Portland, Maine. EPA 440/5-81-010. U.S. Env. Protection Agency. Washington, D.C. pp. 146-152.

This paper summarizes various aquatic plant control methods and their effectiveness in B.C. Limited copies are available for distribution.

Rudolph, J.R. and C.E.W. Dyer. 1981. Studies on Aquatic Macrophytes. Part XXXI. Volume 1: Data Report. Control of Myriophyllum spicatum in Kalamalka and Wood Lakes using 2,4-D butoxyethanol ester in 1980.

1982

Bryan, A. and G. Armour. 1982. Studies on Aquatic Macrophytes. Part XI. Rotavating and Jetting for aquatic weed control in Okanagan and Kalamalka Lakes. Assessment and Planning Division Working Report, British Columbia Ministry of Environment. 43 pp.

Kangasniemi, B.J. and N. Nagpal. 1982. Studies on Aquatic Macrophytes. Part XXXV. A study of the potential for groundwater contamination from the use of 2,4-D for aquatic weed control. Water Management Branch Report No. 3121. British Columbia Ministry of Environment. 29 pp.

South, E.L. and M.C. Robinson. 1982. Eurasian Water Milfoil Studies. Volume III. Fisheries and waterfowl studies of the Okanagan Basin, 1978. Water Management Branch Report No. 3133. British Columbia Ministry of Environment. 44 pp.

1983

Adams, R.W. 1983. Studies on Aquatic Macrophytes. Part XXVIII. Considerations for the use of the Aqua-Kleen Formulation of 2,4-D to control Eurasian water milfoil in British Columbia. Water Management Branch Report No. 3191. British Columbia Ministry of Environment. 63 pp.

Adams, R.W. 1983. Guidelines for use of the herbicide 2,4-D to control Eurasian water milfoil in British Columbia. In: Lake Restoration, Protection, and Management. Proceedings of the North American Lake Management Society Conference, October 27-29, 1982, Vancouver, British Columbia. U.S. Environmental Protection Agency 44015-83-001. pp. 200-213.

Adams, R.W. and M.A. Wallis. 1983. Studies on Aquatic Macrophytes. Part XXXVIII. Observations on the control of Myriophyllum spicatum in Kalamalka and Wood Lakes using 2,4-D butoxyethanol ester in 1979 and 1980. Water Management Branch Report No. 3192. British Columbia Ministry of Environment. 42 pp.

Kangasniemi, B.J. 1983. Observations on herbivorous insects that feed on Myriophyllum spicatum in British Columbia. In: Lake Restoration, Protection and Management. Proceedings of the North American Lake Management Society Conference, October 27-29, 1982, Vancouver, British Columbia. U.S. Environmental Protection Agency. 44015-83-001. pp. 214-218.

1984

Wallis, M. and M. Maxnuk. 1984. The 1982-1983 Okanagan Valley Eurasian water milfoil control program. Water Management Branch Report No. 3238. British Columbia Ministry of Environment. 44 pp.

Wright, P. 1984. Burlap used as a benthic screen in Kalamalka, Shuswap, and Champion Lakes, British Columbia 1981-1983. Water Management Branch Report No. 3239. British Columbia Ministry of Environment. 24 pp.

POOR

QUALITY

ORIGINAL